INSTRUCTION MANUAL

E 1135
M. CHIEFA
B-95

D12/D13

DUAL BEAM

DISPLAY UNIT

TEKTRONIX®

This is the
INSTRUCTION MANUAL
for your new
Tektronix Instrument

It contains detailed information about the characteristics, operation, circuit description and calibration of your new instrument.

If you have any questions, your local Tektronix Field Engineer is ready to assist you in instrument selection, operation, application and maintenance. Take advantage of the product knowledge that our staff offers.

PLEASE DETACH CARD BEFORE MAILING

Wish to be on our mail list? Just fill in the return card and drop it in the mail.

☐ Please add my name to your general mail list for Tektronix Catalog, Calendar, and TEKSCOPE.

In addition I would like to receive any special mailings on:

☐ Information Display Products ☐ Television Instruments

☐ Please have my Tektronix Field Engineer call me at:

TELEPHONE ( ) _____ EXT. _____
Area Code

NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

FIRST CLASS
PERMIT NO. 61
BEAVERTON, OREGON

BUSINESS REPLY MAIL

No postage necessary if mailed in the United States

Postage will be paid by

TEKTRONIX, INC.
Dept. A
P. O. Box 500
Beaverton, Oregon 97005
U.S.A.

INSTRUCTION MANUAL

Serial Number _____

D12/D13
DUAL BEAM
DISPLAY UNIT

Tektronix, Inc. ● P. O. Box 500 ● Beaverton, Oregon 97005 ● Phone 644-0161 ● Cables: Tektronix

070-1134-00

1071

All Tektronix instruments are warranted against defective materials and workmanship for one year.

Any questions with respect to the warranty, mentioned above should be taken up with your Tektronix Field Engineer or Representative.

All requests for repairs and replacement parts should be directed to the Tektronix Field Office or Representative in your area. This procedure will assure you the fastest possible service. Please include the instrument Type (or Part Number) and Serial or Model Number with all requests for parts or service.

Specifications and price change privileges reserved.

Copyright © 1971 by Tektronix, Inc., Beaverton, Oregon. Printed in the United States of America. All rights reserved. Contents of this publication may not be reproduced in any form without permission of the copyright owner.

U.S.A. and foreign Tektronix products covered by U.S. and foreign patents and/or patents pending.

TABLE OF CONTENTS

	Page
SECTION 1 OPERATING INSTRUCTIONS	
D12 and D13 General Description	1-1
Preliminary Information	1-1
Controls and Connectors	1-1
Basic Operation	1-2
Preparation	1-2
Calibration Check	1-2
Beam Finder	1-2
External Intensity Input	1-2
Storage Operation	1-2
General Information	1-3
Graticule	1-3
Intensity Controls	1-3
Display Focus	1-3
Trace Alignment Adjustment	1-3
Beam Finder	1-3
Care of Storage Screens	1-3
Storage Operation	1-4
Intensity Modulation	1-4
Calibrator	1-4
Display Photography	1-4
Oscilloscope Applications	1-5
Electrical Characteristics	1-5

	Page
SECTION 2 THEORY OF OPERATION	
Block Diagram Description	2-1
Circuit Description	2-1
Deflection Amplifiers	2-1
CRT Circuit	2-1
Storage Circuit (D13 only)	2-2
SECTION 3 CALIBRATION	
Instrument Maintenance	3-1
Services Available	3-1
Test Equipment Required	3-1
Calibration Equipment Alternatives	3-1
Special Calibration Fixtures	3-1
Test Instruments	3-1
Accessories	3-1
Short-Form Procedure and Index	3-1
Calibration Procedure	3-2
SECTION 4 PARTS LIST AND DIAGRAMS	
Electrical Parts List	
Circuit Board Photos With Component Locations	
Diagrams	
Mechanical Parts List	

Abbreviations and symbols used in this manual are based on or taken directly from IEEE Standard 260 "Standard Symbols for Units", MIL-STD-12B and other standards of the electronics industry. Change information, if any, is located at the rear of this manual.

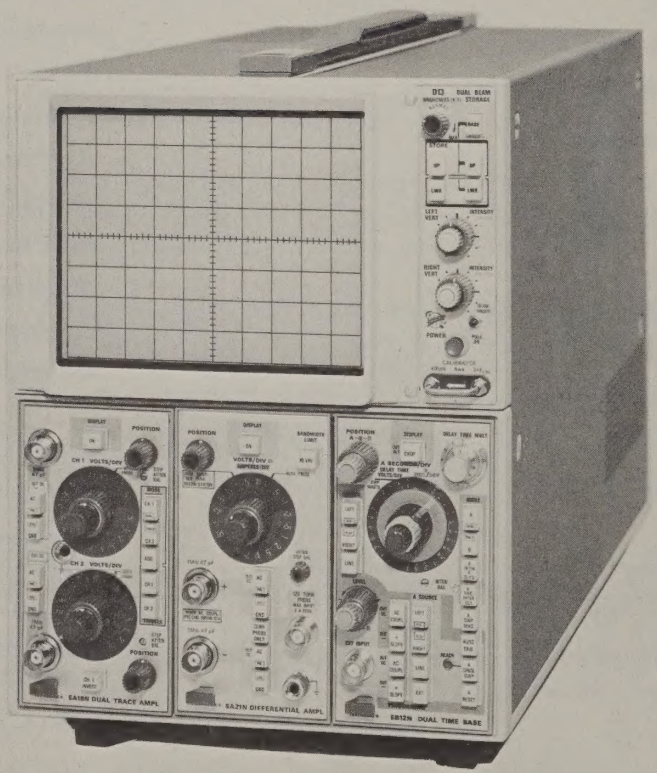


Fig. 1-1. 5103N Oscilloscope with a Dual-Beam Display Unit.

SECTION 1
OPERATING INSTRUCTIONS

Change information, if any, affecting this section will be found at the rear of the manual.

D12 and D13 General Description

The D12 Dual Beam Display Unit or the D13 Dual Beam Storage Display Unit provides a dual-beam cathode-ray tube (CRT) display for Tektronix 5100-series oscilloscopes. Either module is operated with a power supply/amplifier module, and comprises one-half of the oscilloscope mainframe. It has an electrostatic-deflection CRT with an 8 X 10 division (one-half inch per division) internal black graticule. A bright display is provided by a 3.5-kilovolt accelerating potential. Active geometry correction ensures display accuracy throughout the graticule area. Provision is made for application of Z-axis signals, and a front-panel loop provides a calibration signal.

The D13 has a direct-view, bistable storage tube with two 4 X 10 division screens, which can be independently controlled for split-screen applications. A variable Brightness control permits extended storage time and can be used to integrate fast, repetitive displays.

The electrical characteristics on page 1-5 apply over a room temperature range of 0°C to +50°C (+32°F to +90°F). Refer to the 5100-series Oscilloscope System manual for environmental characteristics.

NOTE

Reference to storage controls or storage operation in this manual applies to the D13 only.

Preliminary Information

The Operating Instruction section of the 5100-series Oscilloscope System instruction manual should be referred to for initial preparation. It contains information for installation of modules and plug-ins, correct operating voltage and temperature, and general oscilloscope usage.

CONTROLS AND CONNECTORS

This is a brief description of the function or operation of the front- and rear-panel controls and connectors. More detailed information is given under General Information.

UPPER and LOWER STORE	Button pushed in selects storage operation of associated storage screen. Button out selects normal operation without storage. Each button has push-push action and operates independently of the other.
UPPER and LOWER ERASE	Self-cancelling switch selects screen to be erased. Both buttons pushed in selects both screens.
ERASE	Momentary contact pushbutton initiates erasure of the storage display selected to be erased.
BRIGHTNESS (Y-T)	Provides continuously variable flood-gun current duty cycle from about 10% to 100%, permitting the intensity of a storage display to be varied. Permits extended retention of displayed information; also serves as an integrator for storing fast, repetitive signals.
LEFT VERT INTENSITY	Controls brightness of display associated with the left vertical plug-in unit.
LEFT VERT FOCUS	Provides adjustment to obtain a well-defined display.
RIGHT VERT INTENSITY	Controls brightness of display associated with the right vertical plug-in unit.
RIGHT VERT FOCUS	Provides adjustment to obtain a well-defined display.
POWER	Used to turn instrument power on or off.
BEAM FINDER	Brings both beams on-screen; limits displays to area inside graticule and intensifies both beams.
CALIBRATOR Loop	Provides positive-going accurate 400-millivolt and 4-milliampere square wave at a frequency of twice the line frequency for calibration and probe compensation.
LEFT VERTICAL EXT INTENSITY INPUT (Rear Panel)	Permits application of Z-axis signals to the CRT (DC coupled). Positive-going signal increases intensity of CRT beam associated with the left vertical plug-in unit.
RIGHT VERTICAL EXT INTENSITY INPUT (Rear Panel)	Permits application of Z-axis signals to the CRT (DC coupled). Positive-going signal increases intensity of CRT beam associated with the right vertical plug-in unit.
TRACE ROTATION (Rear Panel)	Permits alignment of the trace with respect to the graticule lines.

BASIC OPERATION

General

The following steps show the use of the controls and connectors of the display unit. It is recommended that this procedure be followed completely for familiarization with this instrument.

Preparation

1. Make sure the oscilloscope system is complete. The display unit must be properly connected to the power supply/amplifier module and the dual-beam auxiliary board must be installed on the plug-in interface board. A 5A-series amplifier plug-in should be in each vertical (left and center) compartments, and a 5B-series time-base plug-in should be in the horizontal (right) compartment.

2. Set the POWER switch off (push in) and connect the display unit to a power source that meets the voltage and frequency requirements of this instrument. See Operating Voltage (Preliminary Procedure) in the Operating Instructions section of the 5100-series Oscilloscope System manual.

3. Turn both INTENSITY controls counterclockwise and pull the POWER switch out to turn the instrument on. Set the front-panel controls as follows:

Display Unit (D12 or D13)

FOCUS (both)	Centered
UPPER and LOWER STORE	Non-store (buttons out)
BRIGHTNESS (Y-T)	Clockwise

Amplifier Plug-ins (both)

Display	On
Position	Centered
Volts/Div	.2
Variable Volts/Div	Cal (fully clockwise)
Input Coupling	DC

Time-Base Plug-in

Display	Alternate (button out)
Position	Centered
Seconds/Div	5 ms
Variable Seconds/Div	Cal (fully clockwise)
Sweep Magnifier	Off
Trigggering Level	Counterclockwise
Triggering Source	Dis Play (Left and Right button in)
Triggering/Sweep Mode	Auto Trig, DC Coupling, +Slope, Normal Sweep

4. Advance the INTENSITY controls until the traces are at the desired viewing level. The traces should appear near the graticule center.

5. Apply a signal from the CALIBRATOR loop to the input connectors of both amplifier plug-ins through a 1× probe or test lead and a dual input cable.

6. Turn the Triggering Level control clockwise until a stable display is obtained. Adjust the vertical and horizontal Position controls so the left vertical display is in the top half of the graticule area and the right vertical display is in the bottom half, and the displays start at the left edge of the graticule.

7. Adjust the FOCUS controls for sharp, well defined displays over the entire trace length.

8. Disconnect the input signal and position either trace vertically so it coincides with the center horizontal line of the graticule.

9. If the trace is not parallel with the center horizontal line, see Trace Adjustment in this section.

Calibration Check

10. Set the Volts/Div switches of both vertical plug-ins to .1, and move both traces two divisions below graticule center. Reconnect the calibration signal to the input connectors of both vertical amplifier plug-ins.

11. The display should be four divisions in amplitude with six complete cycles (five complete cycles for 50-hertz line frequency) shown horizontally. An incorrect display indicates that the oscilloscope mainframe or plug-ins need to be recalibrated.

12. Rotate the RIGHT VERT INTENSITY control counterclockwise and set the time-base Triggering Source to Left.

NOTE

The remainder of the procedure is performed using the Left Vertical controls only, since just one display is needed to demonstrate the remaining control functions.

Beam Finder

13. Move the display off-screen with the left vertical amplifier Position control.

14. Push the BEAM FINDER button and observe that the display compresses into the screen area. Reposition the display to screen center and release the BEAM FINDER button.

External Intensity Input

15. Move the calibrator signal from the amplifier plug-in input connectors and apply it to the LEFT VERTICAL EXT INTENSITY INPUT connector on the rear panel.

16. Set the Triggering Source to Line and slowly rotate the LEFT VERT INTENSITY control counterclockwise until the trace appears to be a series of dimmed and brightened segments. The brightened segments correspond with the tops of the calibrator square waves.

Storage Operation

17. Move the calibrator signal from the EXT INTENSITY INPUT connector to the left vertical amplifier plug-in unit input connector.

18. Set the Triggering Source to Left, turn the LEFT VERT INTENSITY control counterclockwise and press both the UPPER and LOWER STORE buttons. A background light level will be present on the storage screen.

19. Simultaneously press both the UPPER and LOWER ERASE screen-selector buttons and push the ERASE button to erase both screens and prepare the targets for storage.

20. Advance the INTENSITY control slowly in the clockwise direction to produce a waveform of normal intensity, then turn the control to the counterclockwise (minimum intensity) position. A stored waveform should remain on the storage screen.

21. Set the time-base plug-in to the Single Sweep Mode (Single Sweep button in).

22. Turn the BRIGHTNESS (Y-T) control counterclockwise and note that the stored display dims. Then turn the control clockwise to normal brightness.

23. To demonstrate independent screen operation, push the UPPER ERASE screen-selector button to release the LOWER ERASE button. Press the ERASE button and note that only the upper screen erases. Push the LOWER ERASE button (UPPER ERASE releases) and press the ERASE button. Set either screen to non-store (STORE button out) and note that the other screen is fully operable in the storage mode, permitting simultaneous store and non-store operation.

This completes the basic operating procedure of the display unit. Instrument operations not explained here, or operations which need further explanation are discussed under General Operating Information.

GENERAL INFORMATION

Graticule

The graticule of the display unit is internally marked on the faceplate of the CRT to provide accurate, no-parallax measurements. The graticule is marked with eight vertical and ten horizontal divisions. Each division is one-half inch square. In addition, each major division is divided into five minor divisions. The vertical gain and horizontal timing are calibrated to the graticule so accurate measurements can be made from the graticule.

Intensity Controls

Two INTENSITY controls are provided, one for each CRT beam. Each CRT beam is associated with one of the vertical deflection systems; thus, the LEFT VERT INTENSITY controls the intensity of the display associated with the left vertical plug-in unit and the RIGHT VERT INTENSITY controls the intensity of the display associated with the right vertical plug-in unit. These controls are adjusted so the displays are easily visible, but not overly bright. Readjustment will probably be required for different displays or sweep rates. Particular care should be exercised when only a spot is displayed. A high-intensity stationary spot may burn the CRT phosphor and cause permanent damage to the CRT if allowed to remain too long.

Display Focus

A FOCUS control is associated with each CRT beam. If a well-defined display cannot be obtained with the FOCUS control, even at low intensity settings, adjustment of the internal astigmatism control may be required.

To check for proper setting of the Astig control, slowly turn the FOCUS control through the optimum setting with a signal displayed on the CRT screen. If the Astig control is correctly set, the vertical and horizontal portions of the trace will come into sharpest focus at the same position of the FOCUS control.

Trace Alignment Adjustment

If a free-running trace is not parallel with the horizontal graticule lines, set the TRACE POSITION adjustment (rear panel) as follows: Position the trace to the center horizontal line and adjust the TRACE ROTATION control so the trace is parallel with the horizontal graticule lines.

Beam Finder

The BEAM FINDER switch provides a means of locating a display which overscans the viewing area either vertically or horizontally. When the BEAM FINDER switch is pressed, the display is compressed within the graticule area. To locate and reposition an overscanned display, use the following procedure.

1. Press the BEAM FINDER switch, and while holding it in, increase the vertical and horizontal deflection factors until the display is reduced to about two divisions vertically and four divisions horizontally (the horizontal deflection needs to be reduced only when in the X-Y mode of operation).

2. Adjust the vertical and horizontal position controls to center the display about the vertical and horizontal centerlines.

3. Release the BEAM FINDER switch; the display should remain within the viewing area.

Care of Storage Screens

To prolong the useful life of the storage screens, the following precautions should be observed when operating the D13.

1. Use minimum beam intensity required to produce a clear, well defined display. Care must be taken in the degree of writing-beam intensity that is used, particularly when using slow sweep rates and X-Y displays. Too-high beam intensity may permanently damage the CRT screen.

2. Avoid repeated use of the same area of the screen. If a particular display is being stored repeatedly, change the vertical position occasionally to use other portions of the display area.

3. Do not leave a stored display on the screen when it is no longer needed.

4. Turn the Store BRIGHTNESS (Y-T) control fully counterclockwise (with sweep held off) when storing a display for an extended period of time.

5. Operate in the non-store mode unless storage is required.

Storage Operation

General. Separate STORE switches are provided for both the upper and lower CRT storage screens, permitting independent screen operation. When both screens are operated in the non-stored mode (both the UPPER and LOWER STORE switches out), the instrument operates as a conventional oscilloscope. When either or both screens are operated in the storage mode (applicable STORE switch in), a display can be retained for further analysis.

A stored display is erased by first selecting the applicable screen for erasure and then pushing the ERASE button. The erasure of one screen has no effect on the other. The UPPER and LOWER ERASE switches are self-cancelling; when either button is pressed, the other button is released. Also, both switches can be pressed in or released at the same time. Thus either screen or both can be selected for erasure, or erasure of both screens can be prevented. The ERASE momentary-contact switch initiates the waveform required for erasure.

Holding and Viewing Modes. The BRIGHTNESS control permits extended retention of displayed information with negligible reduction in CRT life. The control provides continuously variable flood-gun current duty cycle from about 10% to 100%. To hold a stored display, set the time-base plug-in unit to Single Sweep and turn the control fully counterclockwise. In this position, the storage-target flood guns are on only 10% of the time, producing the effect of decreased intensity. A stored display will be very faint and may not be discernible from the background areas. Both screens are affected. To return the instrument to a viewing mode, turn the BRIGHTNESS control clockwise until the desired viewing level is achieved. In the full clockwise position, the flood guns are on 100% of the time and stored display will be its brightest. The BRIGHTNESS control is inoperable for X-Y displays and when the sweep is running. If the control is counterclockwise and the sweep is running, a blinking effect will be noticeable at the slower sweep rates because the CRT will revert to the hold mode between sweeps. To eliminate this effect, turn the control clockwise.

Integrating Fast Displays. If fast, repetitive displays cannot be stored even at maximum intensity settings, the BRIGHTNESS control can be used to increase the apparent writing speed of the CRT. To use this function, first obtain a triggered, well focused display of the signal in the non-store mode. Adjust the writing-beam INTENSITY control so the trace is just starting to defocus. Then press in both STORE buttons and erase the screen. Turn the BRIGHTNESS control counterclockwise and press the STORE button to obtain the non-store mode. Wait about two seconds, press in both STORE buttons and rotate the BRIGHTNESS control clockwise to view the integrated display. If all portions of the display are not properly stored, rotate the BRIGHTNESS control counterclockwise and return to the non-store mode to integrate the display for a few seconds more. If too much integration time is used, the stored image begins to broaden, or background fade-up may occur, obscuring the desired display. Some practice may be necessary to determine the proper intensity level and integration time required for obtaining best results.

Intensity Modulation

Intensity (Z-axis) modulation can be used to relate a third item of electrical phenomena to the vertical (Y-axis) and the horizontal (X-axis) coordinates without affecting the waveshape of the displayed signal. The Z-axis modulating signal applied to the EXT INTENSITY INPUT changes the intensity of the displayed waveform to provide this type of display. The voltage amplitude required for visible trace modulation depends on the setting of the INTENSITY control. About +5 volts will turn on the display to a normal brightness level from an off level, and about —5 volts will turn the display off from a normal brightness level. "Gray scale" intensity modulation can be obtained by applying signals between these levels. Maximum safe input voltage is + or— 50 volts. Usable frequency range of the Z-axis circuit is DC to one megahertz.

Time markers applied to the EXT INTENSITY INPUT provide a direct time reference on the display. With uncalibrated horizontal sweep or X-Y operation, the time markers provide a means of reading time directly from the display. However, if the markers are not time-related to the displayed waveform, a single-sweep display should be used (for internal sweep only) to provide a stable display.

Intensity modulation can be used in the store mode as well as in the non-store mode; however, there is only one intensity level in a stored display. The stored waveform may be modified by either dimming portions of the waveform so they do not store, or brightening portions from a dim background so only the brightened portions store.

Calibrator

The internal calibrator of the display unit provides a convenient signal source for checking the basic vertical gain and sweep timing. The calibrated signal is also very useful for adjusting probe compensation as described in the probe instruction manual. The output square-wave voltage is 400 millivolts, within 1%, and the square-wave current is 4 milliamperes, within 1%. The frequency of the square-wave signal is twice the power-line frequency. The signal is obtained by clipping the probe to the loop.

Display Photography

A permanent record of the CRT display can be obtained with an oscilloscope camera system. The CRT bezel provides integral mounting for a Tektronix oscilloscope camera. A camera with a light source is required to illuminate the graticule in the non-store mode. The instruction manuals for the Tektronix oscilloscope cameras include complete instructions for obtaining waveform photographs. The following specific information is given for photographing stored displays.

When this instrument is operated in the storage mode, a photograph may easily be composed by erasing unwanted displays as many times as necessary before the desired display is obtained. This ability to compose a photograph in advance prevents wasted film due to incorrect displays.

Due to the background glow of the stored display produced by the flood guns, special care must be taken in determining the exposure time and f-stop settings. Of course, exact settings will depend upon the specific types of film. After the correct settings are obtained for a specific oscilloscope-camera-film combination, record these figures for future reference. Since the background glow does not change substantially between displays, these settings should produce satisfactory results for most displays. Background glow may be altered by adjustment of the BRIGHTNESS control.

Oscilloscope Applications

The 5100-series Oscilloscope, including its associated display module and plug-ins, provides a very flexible measurement system. Specific application for the individual plug-ins are described in the manuals for those units. Refer to the Operating Instructions section of the 5100-series Oscilloscope manual for basic oscilloscope applications, including peak-to-peak AC voltage measurements, instantaneous DC voltage measurements, comparison measurements, time duration measurements, determining frequency, risetime measurements, and X-Y measurements.

Electrical Characteristics

Cathode-Ray Tube. Size is 6½ inches with an 8 X 10 division (½ inch/div.) display area. P31 phosphor is standard for the D12; similar to P1 for the D13. Accelerating voltage is 3.5 kV; orthogonality, 90° (within 1°); geometry, 0.1 division or less.

Storage Display (D13 Only). Writing speed is at least 20 divisions per millisecond; storage time, one hour (longer at low brightness); erase time, about 250 milliseconds.

External Intensity Input. +5 volts will turn on display to a normal brightness level from an off level; —5 volts will turn display off from a normal brightness level. Usable frequency range is DC to one megahertz; input R and C, about 100 kΩ paralleled by about 40 pF; maximum safe input, +50 volts (DC+ peak AC).

Calibrator. Voltage amplitude is 400 mV, within 1%; current, 4 mA, within 1%. Frequency of square-wave signal is twice the line frequency.

Power Input. With the standard transformer, the 5103N Oscilloscope will operate from nominal 110V and 120V (within 10%) line voltage sources having frequencies of 60 hertz or 400 hertz. With the optional export transformer, the 5103N Oscilloscope will operate from nominal 100V, 110V, 120V, 200V, 220V and 240V (all within 10%) line voltage sources having frequencies of 50 to 60 hertz or 400 hertz.

SECTION 2
THEORY OF OPERATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains an electrical description of the circuits in the D12 and D13 Display Units. An overall block diagram of these units and complete schematics are given on pullout pages at the rear of this manual.

BLOCK DIAGRAM DESCRIPTION

The Vertical and Horizontal Deflection Amplifiers provide final amplification of the signals from the plug-in units. They produce push-pull outputs suitable to drive the CRT vertical and horizontal deflection plates. Separate vertical amplifiers are provided for independent dual-beam display of signals from the left and right vertical plug-in units. Beam-finding circuitry limits the display within the screen area when the front-panel BEAM FINDER button is pressed.

The CRT Circuit produces the high voltage (about —3400 volts) and contains the controls necessary for operation of the cathode-ray tube. The CRT Circuit also contains the Z-Axis Amplifier, which provides drive signals to control the intensity levels of the displays produced by both CRT beams.

The Storage Circuit provides the voltage levels necessary to operate the storage elements associated with the CRT in the D13. The circuit includes the erase-pulse generator for erasing stored information and a multivibrator which permits the flood-gun duty cycle to be varied.

CIRCUIT DESCRIPTION

Deflection Amplifiers

Vertical Deflection Amplifiers. The left and right Vertical Deflection Amplifiers provide the final amplification of signals applied to the left and right vertical plug-in units. These are differential amplifiers which produce push-pull outputs suitable to drive the CRT left and right vertical deflection plates for independent dual-beam displays. The left amplifier consists of Q164, Q166, Q174 and Q176, and the right amplifier consists of Q104, Q106, Q114 and Q116.

The input signal arrives via P612 from the plug-in interface circuit (power supply/amplifier module). The output signal is developed across the collector-load resistors of the output transistors, and is about 50 times the magnitude of the input signal. Variable resistors R116 and R176 (Right and Left Vert Gain) provide emitter degeneration to set the gain of their respective amplifiers to provide a calibrated vertical display.

Horizontal Deflection Amplifier. The Horizontal Deflection Amplifier consists of Q124, Q126, Q134 and Q136, and is basically the same as the Vertical Deflection Amplifiers just described. It provides final amplification of signals from the horizontal plug-in unit, which arrive via P611. Gain of the stage is set by R136, Horiz Gain, to provide a calibrated horizontal display.

Beam Finder. If a high-amplitude signal or a misadjusted control has deflected the trace or display off-screen, it can be located by pressing the front-panel BEAM FINDER push-button. This opens S223 (CRT Circuit diagram), allowing current to flow through R179 into the emitter circuits of the deflection amplifiers. R179 limits the current available to the transistors, and hence, to the collector-load resistors. Thus the dynamic range of the deflection plates is limited to an on-screen level, and the display is compressed within the viewing area. The intensification function of the Beam Finder is discussed in the Z-Axis Amplifier description.

X-Y Phasing. Variable capacitors C115 and C175 are connected across the output collectors of their respective Vertical Deflection Amplifiers. These capacitors are adjusted to eliminate the inherent phase difference between the vertical and horizontal deflection systems when operating in the X-Y mode.

Dynamic Geometry. Because each CRT gun is physically located off-center in the vertical plane, the beams emitted by these guns pass through an uneven magnetic field as they sweep across the screen. To compensate for the effects that the unbalanced field would have on display geometry, a dynamic geometry circuit made up of full-wave rectifier CR141-CR142 and operational amplifier Q148 applies a voltage to the vertical deflection plate shield. As the beam moves from the left towards CRT center, CR142 conducts, and the voltage applied to the shield increases in a sawtooth fashion. When the beam passes the center and continues toward the right edge of the screen, CR142 turns off and CR141 turns on, and the voltage applied to the shield decreases in a sawtooth fashion. The peak of this voltage waveform corresponds to the CRT center, and the ramp voltages are directly proportional to the distance of the CRT spot from the screen center. R145, Dynamic Geometry, adjusts the constant factor of the ratio.

Because the unregulated +200-volt collector supply of Q148 may have an undesirable effect on geometry due to ripple, the ripple component is injected via operational amplifier Q154 to the base of Q148 to cancel this effect.

CRT Circuit

General. The CRT Circuit produces the high-voltage potential and provides the control circuits necessary for operation of the cathode-ray tube (CRT). This circuit also includes the Z-Axis Amplifier circuit, which controls the CRT intensity level of both beams from several inputs.

Z-Axis Amplifier. The Z-Axis Amplifiers establish the biasing conditions of the CRT to control the intensity levels of both beams. They are current-driven, shunt-feedback operational amplifiers with voltage outputs; they consist of Q232-Q234 for the left electron gun, and Q432-Q434 for the right electron gun.

The output levels of the Z-Axis Amplifiers are established by the voltage drops across feedback resistors R236 and R436 in reference to virtual ground at the operational amplifier summing points (Q232 and Q432 bases). The currents through these feedback resistors are determined by input currents from any combination of several sources. Individual INTENSITY controls, R200A and R400A, permit the quiescent intensity levels of both beams to be adjusted independently. An EXT INTENS INPUT, J203 or J403, is provided for each Z-Axis Amplifier; the external signals are applied via operational amplifiers Q206 and Q406. The remaining inputs are simultaneous to both Z-Axis Amplifiers, and thus affect both CRT beams. The sweep blanking and chop blanking inputs are applied via emitter followers Q214 and Q218 to turn off the CRT beams during sweep retrace and during the chop-switching transitions. When BEAM FINDER switch S223 is pressed, Q224 saturates, resulting in a slight increase in the CRT beam intensity levels.

High-Voltage Primary. A repetitive, non-sinusoidal signal is produced by a phase-modulated switching circuit in the primary of T240 and induced into the secondaries. Current drive for the primary winding is furnished by Q252 in its conduction state. Q252 is turned on by positive-going feedback applied through C259 and L259 from the feedback winding, and then turned off by switching action from Q262. A sample of the output DC voltage is modulated by the AC from another feedback winding at the gate of Q268 to establish the conduction time of Q252, and thus maintain the proper output level. Q252 delivers energy to T240 only once each cycle.

Assuming Q262 and Q264 are off initially, R262 provides base drive for Q252, causing it to deliver current to T240 primary. As Q252 conducts, its increasing current through the primary winding induces a voltage into the secondaries. The gate of Q268 is driven negative by the voltage from the feedback winding, switching Q264 and Q262 on. With conduction of Q262, base drive for Q252 is removed.

With Q252 off, the transformer field collapses, reversing the polarity of the voltage induced into the secondaries. When the gate of Q268 is driven sufficiently positive to switch Q264 and Q262 off, Q252 is switched on again. Q252 again delivers energy to the primary winding and the action is repeated.

High-Voltage Regulation. Regulation is accomplished as follows: Feedback from the —3400-volt cathode supply is summed with the low-voltage levels through the voltage divider consisting of resistors R272A, R272B, R274, R275 and R276 to establish the DC level at the gate of Q268. The AC component, which is the switching signal, is derived from the transformer as described previously. If the output level of the cathode supply drops below the nominal —3400-volts (becomes more positive), the level at the gate of Q268 rises. A new point is selected on the varying AC component to cause Q262-Q264 to switch later and thus increase the conduction time of Q252. This allows more energy to be delivered to the primary winding of T240, resulting in an increase of voltage in the secondaries. Conversely, if the output level increases, Q252 is allowed to conduct for a shorter length of time. The DC level at the gate of Q268 is adjusted by R275, High Voltage, to set the voltage on the CRT cathode to exactly —3400 volts.

Electron Gun Cathode and Grid Supplies. Half-wave rectifier CR247 produces —3500 volts DC, which is applied to Q454 and VR458. Each of these devices drops 100 volts, establishing the —3400-volt cathode potential. Conduction of Q454 in the right cathode circuit is controlled by R455, Horiz Bal, to balance the horizontal sensitivity of the two displayed traces. The 6.3-volt cathode heater is elevated to —3.5 kV through R459.

Bias voltage for each grid is supplied by identical DC restorer networks, which consist of CR243, CR244, and R244 for the right grid and CR443, CR444 and R444 for the left grid. These DC resistors have the —3400-volt cathode potential applied to them as a reference voltage, and they are driven by a varying voltage obtained from one side of the 400 VAC winding of T240. R242, Right Inten Range, and R442, Left Inten Range, provide a fine adjustment of the quiescent grid voltage to bias both electron guns just below cutoff when the Z-Axis Amplifier output is at its minimum quiescent level (INTENSITY controls counterclockwise and no intensifying or blanking inputs). A change in the Z-Axis Amplifier output produces an almost equal change of voltage on the control grid, allowing the Z-Axis Amplifier to control the beam current in the CRT.

CRT Control Circuits. In addition to the INTENSITY controls discussed previously, front-panel focus and internal astigmatism controls have been incorporated for arriving at an optimum CRT display. FOCUS controls R200B and R400B provide the correct voltage for the first anode of each gun. Proper voltages for the second anodes are obtained by adjusting the Right and Left Astig controls, R286 and R486. In order to obtain optimum spot size and shape, both the focusing and astigmatism controls are adjusted to provide the proper electrostatic lens configuration in the CRT.

Two adjustments control the trace alignment. TRACE ROTATION control R291 permits adjustment of the DC current through beam-rotation coil L291 to align the display with the horizontal graticule lines. Beam Regis control R285 varies the voltage between two special sets of deflection plates to align the two traces horizontally, ensuring correct time relationship (registration) between the traces and the vertical graticule lines. Geom control R289 varies the positive level on the horizontal deflection plate shield to control the overall geometry of the display. The dynamic geometry correction which is applied to the vertical deflection plate shields has been discussed previously.

Storage Circuit (D13 Only)

General. The CRT used in the D13 is a direct-view, bistable storage cathode-ray tube with a split-screen viewing area that permits each half to be operated individually for stored displays. Only those elements associated with the storage capability of the CRT are shown inside the CRT symbol on the right side of the Storage Circuit schematic diagram. The writing gun, its deflection systems and associated elements have been discussed previously.

Storage Operation. Four low-energy electron guns (flood guns) provide full coverage of the large screen area. Each consists of a heated cathode and an anode. The cathode heaters, which receive an unfiltered pulsating DC from full-wave rectifier CR329, are elevated to the cathode potential through R329. Quiescently, Q308 is saturated, providing current to the flood-gun cathodes. The anode potential is established by VR396 and supplied via emitter follower Q396.

The collimation electrode is a metallic band around the inner wall of the CRT envelope. It produces an electrostatic field to distribute the flood-gun electrons uniformly over the storage target. R390, CE1, provides adjustment of the flood-electron trajectories to cover the extreme rim of the targets and optimize uniformity of the target coverage. Emitter follower Q392 maintains a stable voltage on the collimation electrode, providing a low-impedance current path to absorb current variations.

The storage screen consists of a thin tin-oxide layer called the target backplate, which is coated with an insulator material containing finely-ground phosphor particles called the target. A positive voltage potential is applied via Q372 and S372 to the backplate to establish the operating level of the tube, which is the difference in potential between the backplate and the flood-gun cathodes. The CRT screen area is divided into two halves, which are electrically insulated from each other to permit independent operation.

The target operates in a bistable mode because of the secondary-emission properties of the insulator material. The stable state is the rest potential, at which the target has gathered low-energy flood-gun electrons, causing it to charge down to the flood-gun cathode potential. The second stable state is the stored state, at which the target (or portions of it) is shifted to the backplate potential by increasing the secondary emission. While the flood guns do not have sufficient energy to shift the target to the stored state, they do supply sufficient energy to hold the target in the stored state after it has been shifted by the high-energy writing-gun beam (CRT beam). This is because the landing energy of the flood electrons has increased with the increased potential difference between the flood-gun cathode and the target. These higher energy electrons yield a light output and produce a visual display as long as the flood beam covers the target.

When the stored display is no longer needed, the information is erased by first shifting the entire target to the stored state and then removing the charge. A positive-going, short duration pulse is first applied to the backplate, increasing the flood-gun electron landing energy and writing the entire target area. Next, the backplate voltage is pulled well below the rest potential of the target, which follows due to its inherent capacitive coupling. Then, as the backplate is gradually returned to its quiescent potential, the target charges to the rest potential and is ready to write again.

For a comprehensive study of storage tube operating principles, a Tektronix Circuit Concepts book entitled "Storage Cathode-Ray Tubes and Circuits" is available through your local Tektronix, Inc. Field Office or representative. Tektronix Part No. 062-0861-00.

Backplate Supply. A regulated +370-volt DC power supply is incorporated in the Storage Circuit to provide the storage level for the CRT and to ensure a potential sufficient for the erasure process. A winding of high-voltage transformer T240 supplies 400 volts RMS, which is rectified by CR386. Q386 and Q388 are connected as a feedback pair to provide the regulated +370-volt DC output. VR388 establishes the reference voltage, and R387, +370 V Adj, sets the current through Q386 to set the output level. VR387 is a protection device for the transistors, and is normally operated in a region of its characteristics curve below its Zener knee.

Backplate Control. Separate STORE switches, S375A and S375B, are provided for the target backplates to permit each storage screen to be operated individually. In the store mode, the store-level potential for the backplate is supplied by either Q372 or the erase-generator output operational amplifier, depending upon the setting of the ERASE SELECT switches, S372A and S372B.

A high degree of control of the target backplates is maintained by a feedback amplifier system consisting of Q356, Q358, Q362, and Q364. The operational amplifier summing point is at the base of Q356, and the feedback resistor is R355. Variable resistor R350, Store Level, provides an adjustment of the current to the null point, and hence sets the backplate voltage through R355 to an optimum storage level. R370, Store Bal, permits matching the backplate voltages for uniform screen luminance, whether they are selected for erasure or not.

When either or both screens are operated in the store mode, the divider network in the high-voltage regulator circuit is modified to shift the high voltage slightly, correcting for the deflection sensitivity changes that occur. The backplate voltage is applied through either R381 or R382 to the base of Q384, removing the ground potential from the Q384 collector. R385, Sens Correct, permits an adjustable sensitivity correction voltage to be applied to the high-voltage regulator.

Erase Generator. The previously discussed operational amplifier is driven by a monostable multivibrator when it is desired to erase a stored display. The multivibrator consists of Q334, which is normally on, and Q336, which is normally off. When ERASE button S330 is pressed, R330 is grounded, producing a negative-going step through C331 to cut Q334 off. Q336 turns on, and the negative-going step produced at its collector causes a corresponding positive-going step at the output of the operational amplifier. This positive-going step is applied to the target backplate, increasing the storage level and "writing" the entire target.

After an RC-controlled time of 10 milliseconds, the multivibrator reverts to its quiescent state, producing a positive-going step at the collector of Q336 as the transistor turns off. This positive-going step is coupled through C342, and the backplate is pulled negative through the action of the operational amplifier. The target is pulled well below its rest potential. As C342 charges, the voltage at the cathode of CR343 decays from about +20 volts toward the —30-volt supply at an RC-controlled rate until it is clamped at ground by conduction of CR343. This action allows the target backplate to be raised slowly to its operating level, while the target remains at the flood-gun cathode potential. The total time from initiation of erasure to the ready-to-write condition is about 250 milliseconds.

Flood-Gun Cathode Control. As previously mentioned, Q308 provides the current for the flood-gun cathodes. It operates at saturation, establishing a cathode potential of nearly —30 volts. Q308 is controlled by two circuits: a transistor switch activated by the sweep gate and a multivibrator. While the sweep is running, Q304 overrides the multivibrator output and holds Q308 in its conduction state. Emitter follower Q302 receives the sweep blanking input from R203 in the Z-Axis Amplifier circuit; however, the level of interest is the zero volts applied to the base of Q302 while the sweep is running. This level permits the base of Q304 to move slightly negative, biasing the transistor into saturation and grounding the collector of Q320. Through R307-R308 divider action, Q308 is held on.

Between sweeps or when the sweep is held off, the +5-volt sweep-blanking level is applied to Q302, raising its emitter positive. This level switches Q304 off, releasing its hold on Q308. In this condition, Q308 is controlled by collector-coupled multivibrator Q310-Q320. When Q320 conducts, Q308 conducts. Symmetry of the multivibrator is controlled by R313 and R325. R325, BRIGHTNESS, is adjustable to allow Q320 to conduct anywhere from 10% to 100% of the time. Thus the duty cycle of the flood-gun cathodes can be varied from 10% to 100%, which has the effect of varying the stored brightness.

SECTION 3
CALIBRATION

Change information, if any, affecting this section will be found at the rear of the manual.

Introduction

This section of the manual contains a procedure to return the circuits of the D12 and D13 display units to within their designed operating capabilities. Calibration is generally required after a repair has been made, or after long time intervals in which normal aging of components may affect instrument accuracy. For initial inspection to verify instrument operation, the Basic Operation procedure in Section 1 should be used (the instrument is checked with its covers on, using a minimum of peripheral equipment).

Instrument Maintenance

Before complete calibration, throughly clean and inspect this instrument as outlined in the Maintenance section of the Oscilloscope System manual. Also, the system manual contains information for general maintenance of this instrument, including preventive maintenance, component identification and replacement, etc.

Services Available

Tektronix, Inc. provides complete instrument repair and calibration at local Field Service Centers and at the Factory Service Center. Contact your local Tektronix Field Office or representative for further information.

TEST EQUIPMENT REQUIRED

General

The following test equipment and accessories, or the equivalent, is required for complete calibration of the D12 or D13. Specifications given for the test equipment are the minimum necessary for accurate calibration. Therefore, some of the specifications listed here may be less rigorous than the actual performance capabilities of the test equipment. All test equipment is assumed to be correctly calibrated and operating within the listed specification.

Calibration Equipment Alternatives

If other test equipment is substituted, control settings or calibration setup may need altering to meet the requirements of the equipment used. Detailed operating instructions for the test equipment are not given in this procedure. Refer to the instruction manual for the test equipment if more information is needed.

Special Calibration Fixtures

Special Tektronix calibration fixtures are used in this procedure only when they facilitate instrument calibration. These special calibration fixtures are available from Tektronix, Inc. Order by part number through your local Tektronix Field Office or representative.

Test Instruments

1. Vertical plug-in units. Three Tektronix 5A-series amplifiers of the same type are needed for checking X-Y phase relationship; however, only two need be used if the procedure is altered slightly.

2. Time-base plug-in unit. Tektronix 5B10N or 5B12N recommended.

3. DC voltmeter. Minimum sensitivity rating, 3600 volts full scale with an accuracy of at least 3%.

4. Low-frequency sine-wave generator. Frequency, 2 hertz to at least 2 megahertz; output amplitude, from about 0.1 volt to 20 volts peak to peak. For example, General Radio 1310-B Oscillator (use a General Radio 274-QBJ Adapter to provide BNC output).

5. Standard amplitude calibrator. Frequency, about one kilohertz; square-wave output amplitude, 0.2 volt. DC voltage outputs, + and —5 for checking Z-Axis inputs. Tektronix Calibration Fixture 067-0502-01 fills all of these requirements.

Accessories

1. Coaxial cable. 50 ohms impedance, 42-inch length, BNC connectors. Tektronix Part No. 012-0057-01.

2. Dual-input cable. Provides matched signal paths to the X and Y channels; BNC connectors. Tektronix Part No. 067-0525-00.

3. Test lead to connect signal from CALIBRATION loop to the vertical input.

SHORT-FORM PROCEDURE AND INDEX

D12/D13 Serial No. _____

Calibration Date _____

Calibrated By _____

1. Check/Adjust Power Supplies Page 3-3

   Low-Voltage Supplies: Check that each supply is within the tolerance listed in Table 3-1.

   High-Voltage Supply: Meter reading between HV test point and ground is —3400 V, ±170 V. Adjust R275.

2. Check/Adjust CRT Operation Page 3-3

   Intensity Range (both beams): Adjust R442 (Left Inten Range) and R242 (Right Inten Range) to establish CRT bias.

   Astigmatism (both beams): Adjust R486 (Left Astig) and R286 (Right Astig) for sharp displays.

   Trace Alignment: Adjust TRACE ROTATION to align the trace parallel to the center graticule line.

   Geometry: Adjust R289 (Geom) and R145 (Dynamic Geometry) for minimum curvature of traces at screen edges. Beam Alignment and Horizontal Sensitivity: Adjust R285 (Beam Registration) to align the beams at screen center. Adjust R455 (Horiz Bal) to calibrate horizontal sensitivity at screen edges.

3. Check/Adjust Storage Operation Page 3-4

   +370-Volt Supply: Meter reading between TP2 and ground is +370 V, ±7 V. Adjust R387 (+370 V Adj).

   Operating Level: Adjust R350 (Store Level) for best stored display with Erase Selector pushed in.

   Store Balance: Adjust R370 (Store Bal) for stored display with Erase Selector button out. Operating level and store balance levels must match.

   Collimation: Adjust R390 (CE1) for full screen coverage and best uniform brightness over the storage target area.

   Non-Store: Adjust R395 (Non-Store) so screen erases promptly and completely when changing from store to non-store mode.

   Writing Speed: Check that writing speed is ≥20 divisions millisecond.

4. Check/Adjust CRT Deflection System Page 3-5

   Horizontal Centering and Sweep Magnifier Registration: Adjust R675 (Horiz Cent) to establish the horizontal electrical zero at the screen center.

   Vertical and Horizontal Amplifier Gain: Adjust R116 (Right Vert Gain), R176 (Left Vert Gain), and R136 (Horiz Gain) to provide calibrated deflection factor. Adjust R385 (Sensitivity Correction) in the Store mode.

   X-Y Phasing: Check that phase difference between identical amplifier units is 1° or less. Adjust C115 (Right Phase) and C175 (Left Phase).

5. Check Z-Axis Amplifier Page 3-6

   External Intensity Input: +5 V turns the CRT beam on from an off level; —5 V turns the beam off from an on level.

   Beam Finder: Traces can be located.

6. Check Calibrator Loop Page 3-6

   Amplitude and Frequency: Output amplitude is 400 mV, ±1%; frequency is twice the power-line frequency.

CALIBRATION PROCEDURE

Preparation

NOTE

This instrument should be adjusted at an ambient temperature between +20°C and +30°C (between +68°F and +86°F) for best overall accuracy.

1. The D12 or D13 Display Unit is operated with a 5100-series Power Supply/Amplifier unit, forming an oscilloscope mainframe. Remove the side and bottom cabinet panels.

2. Insert an amplifier plug-in unit in each vertical plug-in compartment (left and center). Insert a time-base plug-in unit in the horizontal (right) compartment.

3. Connect the oscilloscope to the power source for which it is wired.

4. Set the controls as given under Initial Control Settings.

Initial Control Settings

NOTE

Do not preset internal controls unless they are known to be significantly out of adjustment, or unless repairs have been made in the circuit. In these instances, the particular controls can be set to midrange.

D12/D13

LEFT VERT	
INTENSITY	Counterclockwise
FOCUS	Midrange
RIGHT VERT	
INTENSITY	Counterclockwise
FOCUS	Midrange
POWER	ON
STORE (UPPER and LOWER)	Non-Store (button out)
BRIGHTNESS (Y-T)	Clockwise

Amplifier Units (both)

Display	On
Position	Midrange
Volts/Div	50 mV
Variable	Calibrated (fully clockwise)
Input Coupling	DC, GND

Time Base Unit

Display Position	Alt (button out) Sweep starts at the left edge of the graticule.
Seconds/Div	0.5 ms
Variable	Calibrated (fully clockwise)
Swp Mag	Off (button out)
Triggering Mode	Auto Trig, AC Coupling, + Slope
Triggering Level	Midrange

1. Check/Adjust Power Supplies

LOW-VOLTAGE SUPPLIES

a. Connect the DC voltmeter between each low-voltage test point and ground.

b. CHECK—Each supply is within the tolerance listed in table 3-1.

NOTE

The tolerance in Table 3-1 includes the possible 3% measurement error of the VOM. If a supply is outside the listed tolerance, refer to the Calibration section of the 5100-series Oscilloscope System manual for complete calibration instructions.

TABLE 3-1

Supply	Tolerance
−30 V	−29.025 V to −30.975 V
+5 V	+4.75 V to +5.25 V
+30 V	+28.95 V to +31.07 V
+205 V	+175 V to +247.5 V

HIGH-VOLTAGE SUPPLY

CAUTION

Turn off instrument power when connecting and disconnecting the DC voltmeter.

c. Connect the DC voltmeter (20 kΩ/volt VOM set to measure at least −3600 volts) between ground and the −3400-volt test point.

d. CHECK—Meter reading must be −3400 volts, ±170 volts. ADJUST—R275, High Voltage, for −3400 volts.

e. Disconnect the DC voltmeter.

2. Check/Adjust CRT Operation

If you are beginning calibration with this step, set the front-panel controls as listed under Initial Control Settings.

INTENSITY RANGE (BOTH BEAMS)

a. Advance the LEFT VERT and RIGHT VERT INTENSITY controls clockwise and check that traces can be obtained, then turn the controls fully counterclockwise.

b. ADJUST—Temporarily set R442 (Left Inten Range) and R242 (Right Inten Range) so two faint traces are visible. Slowly turn each INTENSITY control clockwise until its trace starts to brighten, then set the INTENSITY control 30° clockwise (1 division marked on the panel adjacent to the knob) of this point. Adjust R442 and R242 clockwise until the beams just disappear. The INTENSITY controls can now be adjusted for traces of normal brightness.

ASTIGMATISM (BOTH BEAMS)

c. Connect the low-frequency sine-wave generator output to the left and right vertical plug-in unit input connectors through a coaxial cable and a dual-input cable. Set the sine-wave generator for a 2-kilohertz, minimum amplitude output.

d. Set the input coupling switches of both vertical units to DC and adjust the sine-wave generator so both displays are about 6 divisions in amplitude. Adjust the time-base triggering controls for a stable display.

e. ADJUST—R486, Left Astig, and the front-panel LEFT VERT FOCUS control for best focus of overall left display; R286, Right Astig, and the front-panel RIGHT VERT FOCUS control for best focus of overall right display.

f. Disconnect the sine-wave signal from the vertical input connectors.

TRACE ALIGNMENT

g. Move both traces to the center of the graticule.

h. CHECK—Trace should be parallel to the center graticule line.

ADJUST—TRACE ROTATION control (rear-panel control) to align the trace horizontal.

GEOMETRY

i. Position the left trace to the top of the graticule and the right trace to the bottom.

j. CHECK—Bowing of the traces must not exceed 0.1 division.

ADJUST—R289, Geometry, for minimum curvature of the two traces.

k. Interchange the time-base plug-in unit with either of the amplifier plug-in units to obtain a vertical sweep. Position the vertical trace to the right edge of the graticule. Readjust R289 if the bowing exceeds 0.1 division.

l. Replace the time-base plug-in unit in the horizontal compartment and the amplifier unit in the vertical compartment. Move the left trace to the bottom of the graticule and right trace to the top.

m. CHECK—Bowing of the traces must not exceed 0.1 division.

ADJUST—R145, Dynamic Geometry, for minimum curvature of the two traces.

n. Repeat steps i through m to obtain optimum geometry of the display.

BEAM ALIGNMENT AND HORIZONTAL SENSITIVITY

o. Connect the standard amplitude calibrator output to the left and right amplifier plug-in unit input connectors through a coaxial cable and a dual-input cable. Set the standard amplitude calibrator for a 0.2-volt square-wave output.

p. Set the Second/Div switch to 1 ms, then position the displays so the bottom of the left display and the top of the right display are near the graticule center.

q. ADJUST—Adjust R285, Beam Registration, so the vertical transitions of both displays at the graticule vertical centerline coincide exactly (adjust horizontal positioning as required). Then adjust R455, Horiz Bal, so the vertical transitions at the left and right edges of the graticule coincide exactly.

r. Set the Input Coupling switches of both displays to GND, set the Seconds/Div switch to 0.5 ms, and disconnect the standard amplitude calibrator.

3. Check/Adjust Storage Operation (D13 Only)

If you are beginning calibration with this step, set the front-panel controls as listed under Initial Control Settings, except as follows:

STORE (both UPPER and LOWER)	In
Erase Select (both UPPER and LOWER)	In

+370-VOLT SUPPLY

a. Connect the DC voltmeter (20 kΩ/volt VOM set to measure at least +400 volts) between ground and the +370-volt test point (TP2).

b. CHECK—Meter reading must be +370 volts, ±7 volts. ADJUST—R387, +370 V Adj, for +370 volts.

OPERATING LEVEL

c. Connect the DC voltmeter between the flood-gun cathodes (pin 3 of P389) and the Store Level test point (TP1). Record the voltmeter reading so that if necessary you can return the operating level to the original setting.

NOTE

If CRT performance has been satisfactory, no adjustment of the Store Level control is necessary. Proceed to the Store Balance adjustment.

For replacement CRT's an information card is provided to show the optimum levels established by the factory for the individual CRT. All voltage levels associated with storage operation are made with respect to the flood-gun cathodes.

d. Locate the Writing Threshold (minimum store level) as follows:

1. Turn the INTENSITY control (either one) clockwise until the trace starts to defocus rapidly. Press the ERASE button to prepare the target area for storage.

2. Write about 3 lines per division across both targets by slewing the free-running trace vertically.

3. Carefully check the written lines for breaks or gaps of 0.025 inch or more. If no breaks or gaps are evident after 10 seconds, adjust R350, Store Level, to reduce the operating level by 5 volts.

4. Erase twice, wait 10 seconds, then write again and check for breaks or gaps.

5. Repeat this procedure of decreasing the operating voltage level in 5-volt steps until breaks of 0.025 inch occur. This is the Writing Threshold. Note the voltage and rotate the Store Level control clockwise until the original level noted in step c is reached.

NOTE

Do not change the INTENSITY or FOCUS control settings.

e. Locate the Upper Writing Limit (maximum store level) as follows:

1. Again write about 3 lines per division. Carefully check the stored lines and background for trace spreading or background fade-up. If no trace spreading or background fade-up is evident after 10 seconds, adjust R350, Store Level, to increase the operating level by 5 volts.

2. Erase twice, wait 10 seconds, then write again and check for spreading or fade-up.

3. Repeat this procedure until trace spreading of about 0.025 inch, or background fade-up occurs. This is the Upper Writing Limit. Note this voltage.

f. Adjust R350 for an operating point midway between the Upper Writing Limit and the Writing Threshold.

g. INTERACTION—Collimation and gain are affected if the change in operating level is significant.

STORE BALANCE

h. Move the position lead of the DC voltmeter from TP1 to the store balance test point (TP4).

i. ADJUST—R370, Store Bal, to set the store level to the same voltage as that recorded at TP1.

COLLIMATION

j. Move the positive lead of the DC voltmeter from TP4 to the CE1 test point (TP3).

k. Write the entire screen by slowly positioning the trace vertically. If the screen fails to write, adjust the INTENSITY control slightly clockwise and repeat the process until the screen is fully written. Then turn the INTENSITY control fully counterclockwise.

l. Record the voltage reading before an adjustment is made so that if necessary you can return the collimation voltage to its original setting.

m. With the screen fully written, turn R390, CE1, fully counterclockwise, noting that the screen edges are brightened and pulled. Turn R390 slowly clockwise to the point where the bright area just covers the graticule area.

n. Erase the screen and disconnect the DC voltmeter.

o. INTERACTION—Storage capabilities and display geometry should be rechecked if a significant change was made in the collimation voltage.

p. Fully write both halves of the screen by positioning the trace.

q. ADJUST—Adjust R395, Non-Store, so background glow quickly (less than 1 second) disappears when the upper or lower screen is placed in the non-store mode (STORE button out).

WRITING SPEED

r. Slowly advance the INTENSITY to the point where the trace begins to defocus rapidly.

s. Connect the sine-wave generator output to the left vertical unit input through a coaxial cable. Set the Input Coupling to DC and adjust the sine-wave generator for exactly 3.2 divisions of display amplitude at a frequency of about 1.5 kilohertz.

t. Set the time-base Sweep Mode to Single Sweep and erase the stored display. Alternately store and erase single sweeps while increasing the sine-wave generator frequency in small increments. Allow about five seconds after each erasure before writing another display. Adjust the frequency to the highest rate that will permit the vertical transition of the sine-wave display to store anywhere on the center 6 X 8 division area of the screens, with no more than a 50% loss in luminance, or with the breaks in the trace not exceeding 0.025 inch. This is the maximum writing speed of the CRT.

Maximum writing speed is calculated as follows:

$$\text{Writing Speed (in divisions/second} = \frac{2\pi F\ V_{p\text{-}p}}{2}$$

Substituting the display amplitude of 3.2 divisions for $V_{p\text{-}p}$, the expression is reduced to

$$\text{Writing Speed} \approx 10 \times F.$$

Thus, for example, if the sine-wave generator frequency is two kilohertz or greater, the maximum writing speed of the CRT is 20 divisions/millisecond (20,000 divisions/second) or greater.

u. CHECK—Writing speed is $\geq$20 divisions/millisecond.

NOTE

It may be necessary to repeat this step with a slightly higher trace intensity or store level.

v. Set the Sweep Mode to normal sweep, STORE switches to non-store, and remove the sine-wave generator.

4. Check/Adjust CRT Deflection System

If you are beginning calibration with this step, set the front-panel controls as listed under Initial Control Settings, except as follows:

INTENSITY (both)	Adjust for normal viewing brightness.
Input Coupling (both Vertical plug-ins)	DC

HORIZONTAL CENTERING/SWEEP MAGNIFIER REGISTRATION

a. Set the standard amplitude calibrator for a 0.2-volt square wave and connect its output to the input connectors of both vertical plug-in units through a coaxial cable and dual-input cable. Position the rising edge of one of the square waves to the graticule center vertical line and push in the Swp Mag button on the time-base unit.

b. CHECK—The corresponding rising edge on the magnified sweep must be within two divisions of the graticule center.

ADJUST—While switching between magnified and unmagnified displays, alternately adjust R675, Horiz Cent (see Fig. 5-1 in the 5103N Oscilloscope System manual for location), and the horizontal Position control until the rising edge of both the unmagnified and magnified displays is at the graticule center.

VERTICAL AND HORIZONTAL AMPLIFIER GAIN

NOTE

Use two amplifier plug-ins known to be accurately calibrated, or verify their correct calibration by applying a known signal and measuring the differential output at contacts A7 and B7 of the plug-in connector. The deflection factor at the output is 50 millivolts/division.

c. CHECK—Vertical deflection of each display is 4 divisions, $\pm$0.04 division.

ADJUST—R176, Left Vert Gain, and R116, Right Vert Gain, so the vertical deflection of each display is exactly 4 divisions.

d. Temporarily disconnect the calibrator signal and remove the time-base unit from the oscilloscope mainframe. Install a third amplifier unit into the horizontal compartment, then reconnect the 0.2-volt calibrator signal through a dual-input cable to the input connectors of the left vertical and horizontal amplifier units.

e. Set the input coupling of the amplifier unit in the horizontal compartment to DC and its Volts/Div switch to 50 mV. The display should be two dots joined by a diagonal line. The dots represent opposite corners of a square having sides 4 divisions in length. Adjust the Position controls to center the display.

f. CHECK—Overall horizontal width of display is 4 divisions, $\pm$0.04 division.

ADJUST—R136, Horiz Gain, so the horizontal deflection is exactly 4 divisions.

g. Push in both STORE buttons and erase the screens (D13 only; for the D12 proceed to step j).

h. CHECK—Vertical and horizontal deflection does not change when switching between store and non-store modes.

ADJUST—R385, Sensitivity Correction, so the deflection sensitivity is the same for the store mode as it is for the non-store mode.

i. Set both STORE switches to non-store (buttons out).

X-Y PHASING

j. Set the low-frequency sine-wave generator for a 100-kilohertz, minimum amplitude output. Move the coaxial cable from the standard amplitude calibrator output to the sine-wave generator output to apply the sine-wave signal to the amplifier plug-in units.

k. Adjust the vertical and horizontal Position controls to center the diagonal display, then increase the sine-wave generator amplitude until the display is 6 divisions vertically and horizontally.

l. CHECK—The opening of the loop measured on the graticule center line is 0.07 division or less. This indicates a phase difference of 1° or less between the vertical and horizontal deflection systems.

ADJUST—C175, Left Phase, for minimum loop opening (a straight line) in the diagonal display.

m. Move the calibrator signal (dual-input cable) from the left amplifier unit input to the right amplifier unit input.

n. CHECK—Phase difference between right vertical and horizontal deflection systems is 1° or less.

ADJUST—C115, Right Phase, for minimum loop opening in the diagonal display.

o. Remove the low-frequency sine-wave generator. Remove the amplifier unit from the horizontal compartment and re-install the time-base unit.

BANDWIDTH

The requirement of the deflection amplifiers with respect to bandwidth is that the response is sufficient to pass a signal from any 5A-series plug-in unit. To verify system bandwidth, refer to the calibration sections of the individual plug-in unit manuals.

5. Check Z Axis Amplifier

Set the front-panel controls as listed under Initial control Settings, except as follows:

INTENSITY (both)	Adjust for normal brightness.

EXTERNAL INTENSITY INPUTS

a. Turn the INTENSITY controls until the traces cannot be seen, but do not turn the controls fully counterclockwise.

b. Connect the standard amplitude calibrator output to the LEFT VERTICAL and RIGHT VERTICAL EXT INTENSITY INPUT connectors through a coaxial cable and a dual-input cable. Set the calibrator for a +5-volt DC output.

c. CHECK—Traces of normal brightness are displayed.

d. Disconnect the calibrator signal and adjust the INTENSITY controls for traces of normal brightness. Set the standard amplitude calibrator for —5-volt DC output and reconnect the calibrator signal to the EXT INTENSITY INPUTS.

e. CHECK—Traces are not visible.

f. Remove the standard amplitude calibrator.

BEAM FINDER

g. Press the BEAM FINDER button and observe that the traces brighten slightly and compress into the graticule area.

h. CHECK—While holding the BEAM FINDER button in, neither trace can be positioned off screen.

i. Reposition the traces as desired and release the BEAM FINDER.

6. Check Calibrator Loop

Set the front-panel controls as listed under Initial Control Settings, except as follows:

LEFT VERT INTENSITY	Adjust for normal brightness.
Left Vertical Plug-In	
Volts/Div	.1
Input Coupling	DC
Right Vertical Plug-In	
Display	Off

a. Connect the front-panel CALIBRATOR loop to the left vertical plug-in unit input connector using a test lead. Adjust the time-base unit to trigger on the calibrator signal and set the Seconds/Div switch to display a few cycles of the waveform.

b. CHECK—Display amplitude is 4 divisions, ±0.04 division (400 millivolts, ±1%). Frequency of the calibrator signal is twice the power-line frequency, which can be determined by measuring the length of time for two cycles of display and taking the reciprocal.

c. Disconnect all test equipment.

This completes the calibration procedure.

SECTION 4

PARTS LISTS AND DIAGRAMS

Symbols and Reference Designators

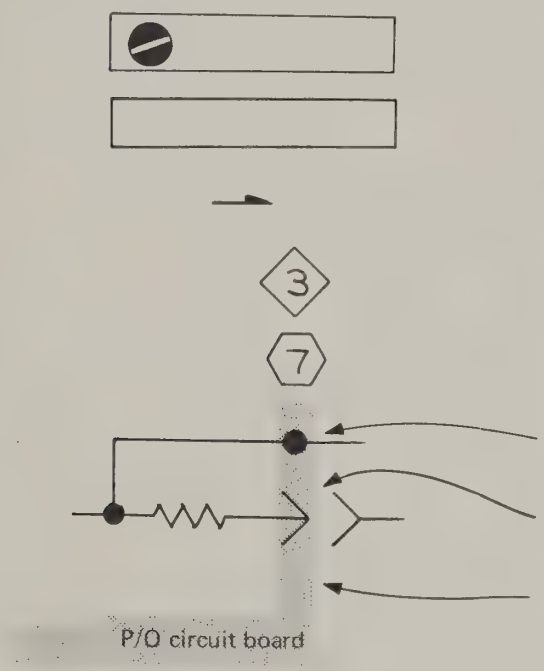
Electrical components shown on the diagrams are in the following units unless noted otherwise:

Capacitors = Values one or greater are in picofarads (pF).
Values less than one are in microfarads (μF).
Resistors = Ohms (Ω)

Symbols used on the diagrams are based on USA Standard Y32.2-1967.

Logic symbology is based on MIL-STD-806B in terms of positive logic. Logic symbols depict the logic function performed and may differ from the manufacturer's data.

The following special symbols are used on the diagrams:



External Screwdriver adjustment.

External control or connector.

Clockwise control rotation in direction of arrow.

Refer to diagram number indicated in diamond.

Refer to waveform number indicated in hexagon.

Connection soldered to circuit board.

Connection made to circuit board with interconnecting pin.

Blue tint encloses components located on circuit board.

The following prefix letters are used as reference designators to identify components or assemblies on the diagrams.

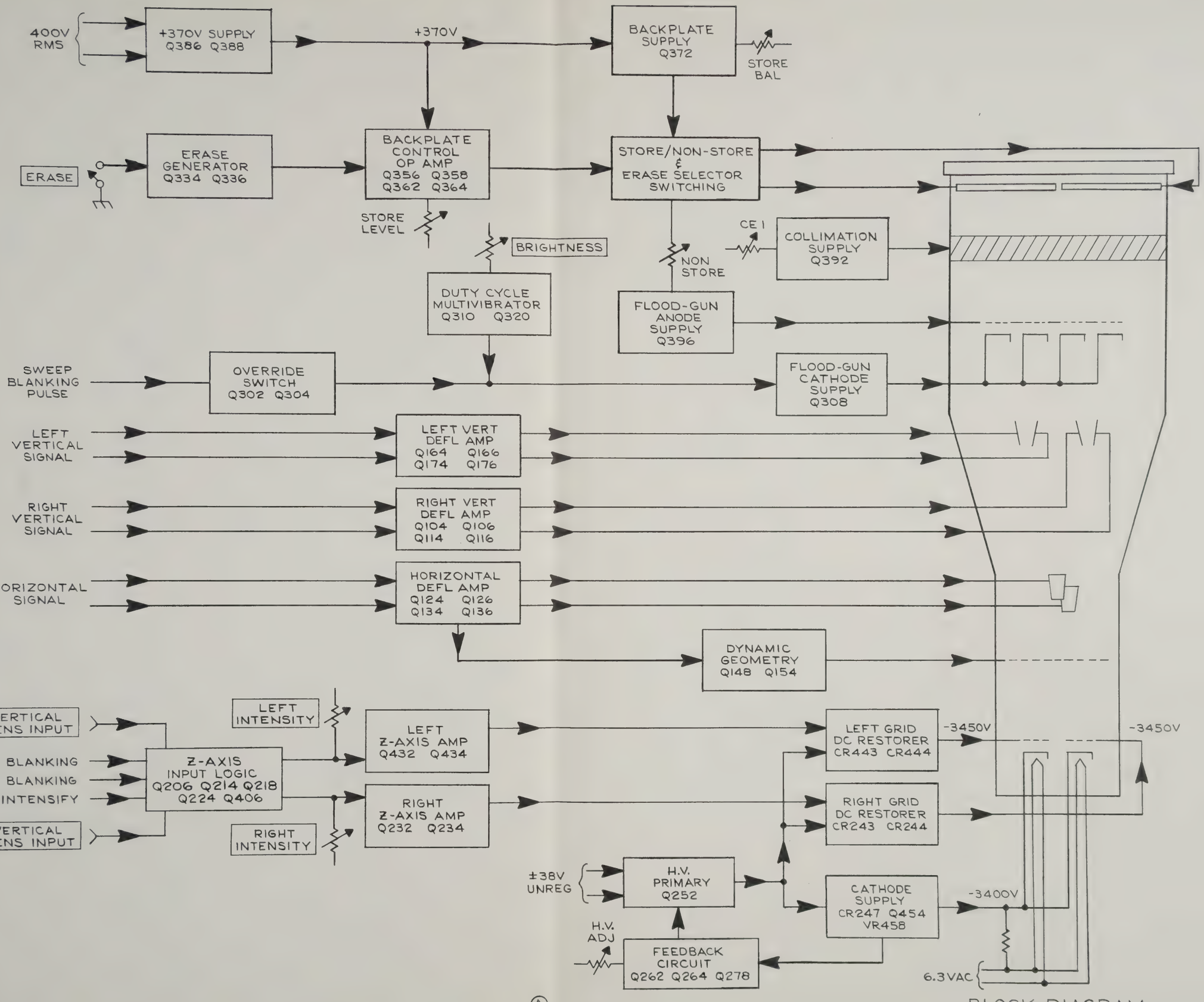
A	Assembly, separable or repairable (circuit board, etc.)
AT	Attenuator, fixed or variable
B	Motor
BT	Battery
C	Capacitor, fixed or variable
CR	Diode, signal or rectifier
DL	Delay line
DS	Indicating device (lamp)
F	Fuse
FL	Filter
H	Heat dissipating device (heat sink, heat radiator, etc.)
HR	Heater
J	Connector, stationary portion
K	Relay
L	Inductor, fixed or variable
LR	Inductor/resistor combination
M	Meter
Q	Transistor or silicon-controlled rectifier
P	Connector, movable portion
R	Resistor, fixed or variable
RT	Thermistor
S	Switch
T	Transformer
TP	Test point
U	Assembly, inseparable or non-repairable (integrated circuit, etc.)
V	Electron tube
VR	Voltage regulator (zener diode, etc.)
Y	Crystal

PARTS LIST ABBREVIATIONS

BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound

PARTS LIST ABBREVIATIONS

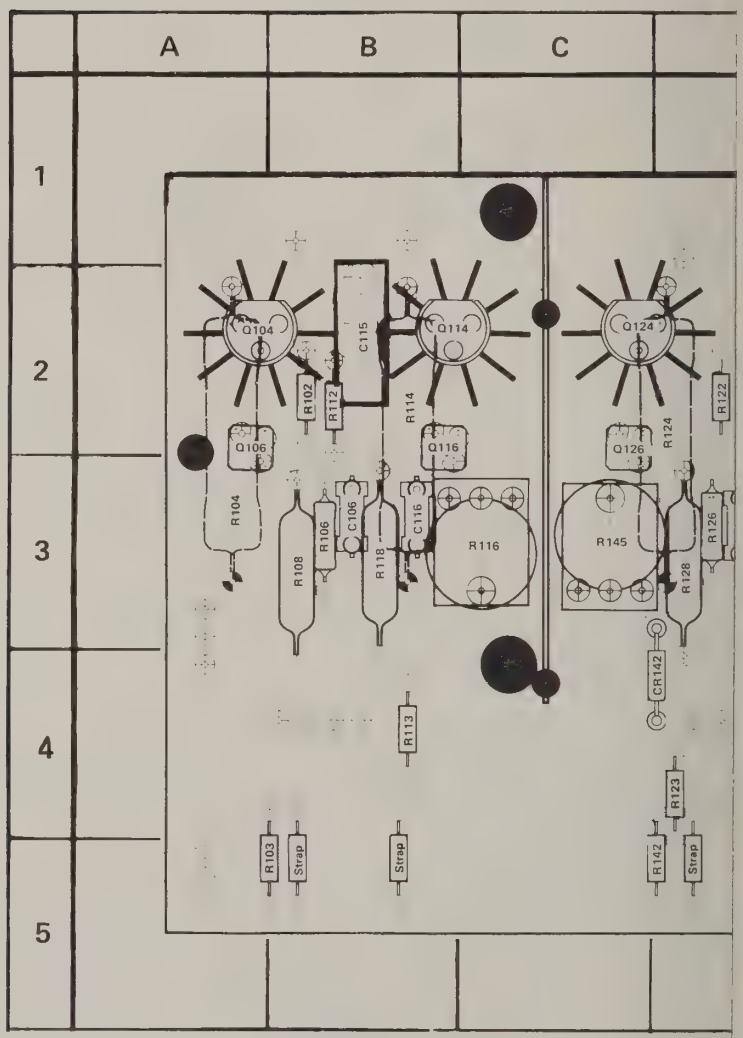
BHB	binding head brass
BHS	binding head steel
cap.	capacitor
cer	ceramic
comp	composition
conn	connector
CRT	cathode-ray tube
csk	countersunk
DE	double end
dia	diameter
div	division
elect.	electrolytic
EMC	electrolytic, metal cased
EMT	electrolytic, metal tubular
ext	external
F & I	focus and intensity
FHB	flat head brass
FHS	flat head steel
Fil HB	fillister head brass
Fil HS	fillister head steel
h	height or high
hex.	hexagonal
HHB	hex head brass
HHS	hex head steel
HSB	hex socket brass
HSS	hex socket steel
ID	inside diameter
inc	incandescent
int	internal
lg	length or long
met.	metal
mtg hdw	mounting hardware
OD	outside diameter
OHB	oval head brass
OHS	oval head steel
P/O	part of
PHB	pan head brass
PHS	pan head steel
plstc	plastic
PMC	paper, metal cased
poly	polystyrene
prec	precision
PT	paper, tubular
PTM	paper or plastic, tubular, molded
RHB	round head brass
RHS	round head steel
SE	single end
SN or S/N	serial number
S or SW	switch
TC	temperature compensated
THB	truss head brass
thk	thick
THS	truss head steel
tub.	tubular
var	variable
w	wide or width
WW	wire-wound



Ⓐ

BLOCK DIAGRAM 971

DEFLECTION AMPLIFIER BOA

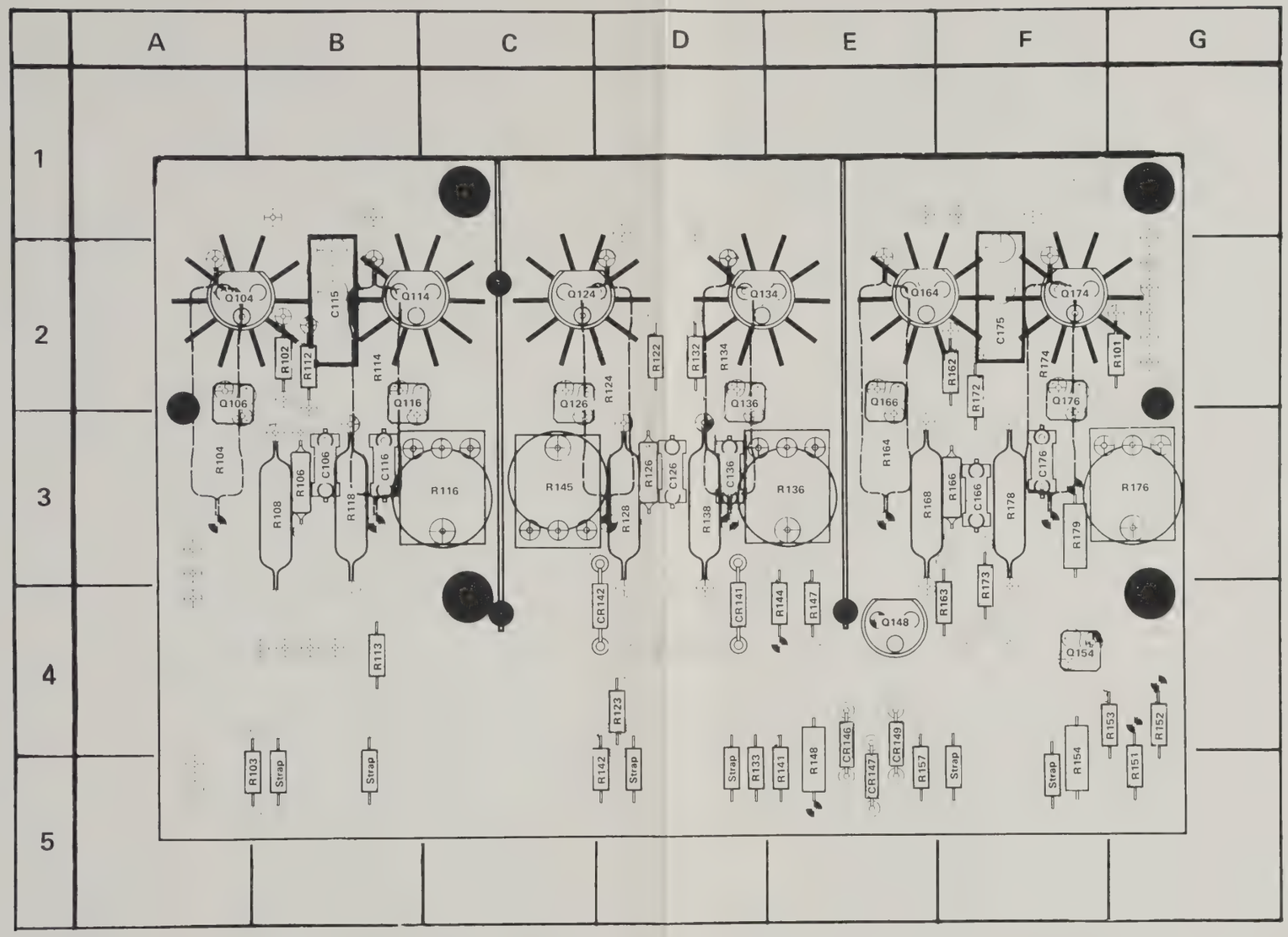


CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO
C106	B-3	CR141	D-4	Q140
C115	B-2	CR142	D-4	Q106
C116	B-3	CR146	E-5	Q114
C126	D-3	CR147	E-5	Q116
C136	D-3	CR149	E-4	Q124
C166	F-3			Q126
C175	F-2			Q134
C176	F-3			Q136
				Q148
				Q154
				Q164
				Q166
				Q174
				Q176

ELECTRICAL PARTS LIST

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLIES				
A1	670-1508-00	B010100	B049999	DEFLECTION AMP Circuit Board Assembly
A1	670-1508-01	B050000		DEFLECTION AMP Circuit Board Assembly
CAPACITORS				
C106	283-0598-00			253 pF, Mica, 300 V, 5%
C115	281-0027-00	B010100	B049999X	0.7-3 pF, Var, Tub.
C116	283-0598-00	B010100	B049999	253 pF, Mica, 300 V, 5%
C116	281-0118-00	B050000		8-90 pF, Var, Mica
C126	283-0604-00			304 pF, Mica, 300 V, 2%
C136	283-0598-00	B010100	B049999	253 pF, Mica, 300 V, 5%
C136	281-0118-00	B050000		8-90 pF, Var, Mica
C166	283-0598-00			253 pF, Mica, 300 V, 5%
C175	281-0027-00	B010100	B049999X	0.7-3 pF, Var, Tub.
C176	283-0598-00	B010100	B049999	253 pF, Mica, 300 V, 5%
C176	281-0118-00	B050000		8-90 pF, Var, Mica
SEMICONDUCTOR DEVICE, DIODES				
CR141	152-0008-00			Germanium, replaceable by T12G
CR142	152-0008-00			Germanium, replaceable by T12G
CR146	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR147	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR149	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
TRANSISTORS				
Q104	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q106	151-0279-00			Silicon, NPN, replaceable by SE7056
Q114	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q116	151-0279-00			Silicon, NPN, replaceable by SE7056
Q124	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q126	151-0279-00			Silicon, NPN, replaceable by SE7056
Q134	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q136	151-0279-00			Silicon, NPN, replaceable by SE7056
Q148	151-0150-00			Silicon, NPN, replaceable by 2N3440
Q154	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q164	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q166	151-0279-00			Silicon, NPN, replaceable by SE7056
Q174	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q176	151-0279-00			Silicon, NPN, replaceable by SE7056
RESISTORS				
R101	316-0101-00			100 Ω, 1/4 W
R102	316-0470-00			47 Ω, 1/4 W
R103	316-0390-00			39 Ω, 1/4 W
R104	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R106	321-0128-00			210 Ω, 1/8 W, Prec, 1%
R108	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R112	316-0470-00			47 Ω, 1/4 W
R113	316-0390-00			39 Ω, 1/4 W
R114	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R116	311-1132-00			100 Ω, Var
R117	316-0470-00	B010100	B049999X	47 Ω, 1/4 W
R118	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%

DEFLECTION AMPLIFIER BOARD PARTS LOCATION



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C106	B-3	CR141	D-4	Q140	A-2	R101	G-2	R142	D-5
C115	B-2	CR142	D-4	Q106	A-2	R102	B-2	R144	E-4
C116	B-3	CR146	E-5	Q114	B-2	R103	B-5	R145	C-3
C126	D-3	CR147	E-5	Q116	B-2	R104	A-3	R147	E-4

ELECTRICAL PARTS LIST

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLIES				
A1	670-1508-00	B010100	B049999	DEFLECTION AMP Circuit Board Assembly
A1	670-1508-01	B050000		DEFLECTION AMP Circuit Board Assembly
CAPACITORS				
C106	283-0598-00			253 pF, Mica, 300 V, 5%
C115	281-0027-00	B010100	B049999X	0.7-3 pF, Var, Tub.
C116	283-0598-00	B010100	B049999	253 pF, Mica, 300 V, 5%
C116	281-0118-00	B050000		8-90 pF, Var, Mica
C126	283-0604-00			304 pF, Mica, 300 V, 2%
C136	283-0598-00	B010100	B049999	253 pF, Mica, 300 V, 5%
C136	281-0118-00	B050000		8-90 pF, Var, Mica
C166	283-0598-00			253 pF, Mica, 300 V, 5%
C175	281-0027-00	B010100	B049999X	0.7-3 pF, Var, Tub.
C176	283-0598-00	B010100	B049999	253 pF, Mica, 300 V, 5%
C176	281-0118-00	B050000		8-90 pF, Var, Mica
SEMICONDUCTOR DEVICE, DIODES				
CR141	152-0008-00			Germanium, replaceable by T12G
CR142	152-0008-00			Germanium, replaceable by T12G
CR146	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR147	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR149	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
TRANSISTORS				
Q104	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q106	151-0279-00			Silicon, NPN, replaceable by SE7056
Q114	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q116	151-0279-00			Silicon, NPN, replaceable by SE7056
Q124	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q126	151-0279-00			Silicon, NPN, replaceable by SE7056
Q134	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q136	151-0279-00			Silicon, NPN, replaceable by SE7056
Q148	151-0150-00			Silicon, NPN, replaceable by 2N3440
Q154	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q164	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q166	151-0279-00			Silicon, NPN, replaceable by SE7056
Q174	151-0190-00			Silicon, NPN, replaceable by 2N3904 or TE3904
Q176	151-0279-00			Silicon, NPN, replaceable by SE7056
RESISTORS				
R101	316-0101-00			100 Ω, 1/4 W
R102	316-0470-00			47 Ω, 1/4 W
R103	316-0390-00			39 Ω, 1/4 W
R104	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R106	321-0128-00			210 Ω, 1/8 W, Prec, 1%
R108	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R112	316-0470-00			47 Ω, 1/4 W
R113	316-0390-00			39 Ω, 1/4 W
R114	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R116	311-1132-00			100 Ω, Var
R117	316-0470-00	B010100	B049999X	47 Ω, 1/4 W
R118	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%

(B)

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R122	316-0470-00			47 Ω, 1/4 W
R123	316-0390-00			39 Ω, 1/4 W
R124	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R126	321-0128-00			210 Ω, 1/8 W, Prec, 1%
R128	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R132	316-0470-00			47 Ω, 1/4 W
R133	316-0390-00			39 Ω, 1/4 W
R134	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R136	311-1132-00			100 Ω, Var
R137	316-0470-00	B010100	B049999X	47 Ω, 1/4 W
R138	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R141	315-0162-00			1.6 kΩ, 1/4 W, 5%
R142	315-0162-00			1.6 kΩ, 1/4 W, 5%
R144	315-0183-00			18 kΩ, 1/4 W, 5%
R145	311-1153-00			5 kΩ, Var
R147	315-0154-00			150 kΩ, 1/4 W, 5%
R148	301-0243-00			24 kΩ, 1/2 W, 5%
R151	315-0754-00			750 kΩ, 1/4 W, 5%
R152	315-0753-00			75 kΩ, 1/4 W, 5%
R153	315-0563-00			56 kΩ, 1/4 W, 5%
R154	301-0392-00			3.9 kΩ, 1/2 W, 5%
R157	315-0822-00			8.2 kΩ, 1/4 W, 5%
R162	316-0470-00			47 Ω, 1/4 W
R163	316-0390-00			39 Ω, 1/4 W
R164	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R166	321-0128-00			210 Ω, 1/8 W, Prec, 1%
R168	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R172	316-0470-00			47 Ω, 1/4 W
R173	316-0390-00			39 Ω, 1/4 W
R174	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R176	311-1132-00			100 Ω, Var
R177	316-0470-00	B010100	B049999X	47 Ω, 1/4 W
R178	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R179	301-0561-00			560 Ω, 1/2 W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R122	316-0470-00			47 Ω, 1/4 W
R123	316-0390-00			39 Ω, 1/4 W
R124	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R126	321-0128-00			210 Ω, 1/8 W, Prec, 1%
R128	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R132	316-0470-00			47 Ω, 1/4 W
R133	316-0390-00			39 Ω, 1/4 W
R134	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R136	311-1132-00			100 Ω, Var
R137	316-0470-00	B010100	B049999X	47 Ω, 1/4 W
R138	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R141	315-0162-00			1.6 kΩ, 1/4 W, 5%
R142	315-0162-00			1.6 kΩ, 1/4 W, 5%
R144	315-0183-00			18 kΩ, 1/4 W, 5%
R145	311-1153-00			5 kΩ, Var
R147	315-0154-00			150 kΩ, 1/4 W, 5%
R148	301-0243-00			24 kΩ, 1/2 W, 5%
R151	315-0754-00			750 kΩ, 1/4 W, 5%
R152	315-0753-00			75 kΩ, 1/4 W, 5%
R153	315-0563-00			56 kΩ, 1/4 W, 5%
R154	301-0392-00			3.9 kΩ, 1/2 W, 5%
R157	315-0822-00			8.2 kΩ, 1/4 W, 5%
R162	316-0470-00			47 Ω, 1/4 W
R163	316-0390-00			39 Ω, 1/4 W
R164	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R166	321-0128-00			210 Ω, 1/8 W, Prec, 1%
R168	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R172	316-0470-00			47 Ω, 1/4 W
R173	316-0390-00			39 Ω, 1/4 W
R174	308-0668-00			6.2 kΩ, 7 W, WW, 3%
R176	311-1132-00			100 Ω, Var
R177	316-0470-00	B010100	B049999X	47 Ω, 1/4 W
R178	308-0539-00			2.25 kΩ, 3 W, WW, 1/2%
R179	301-0561-00			560 Ω, 1/2 W, 5%

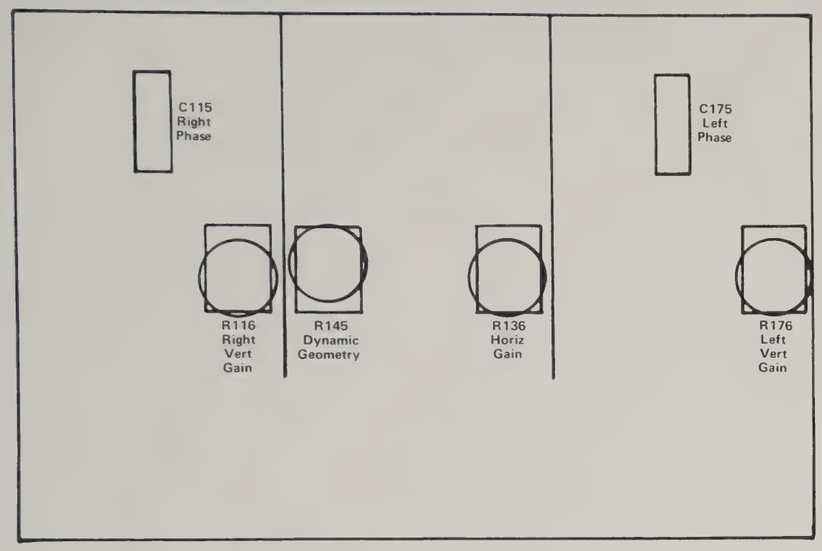
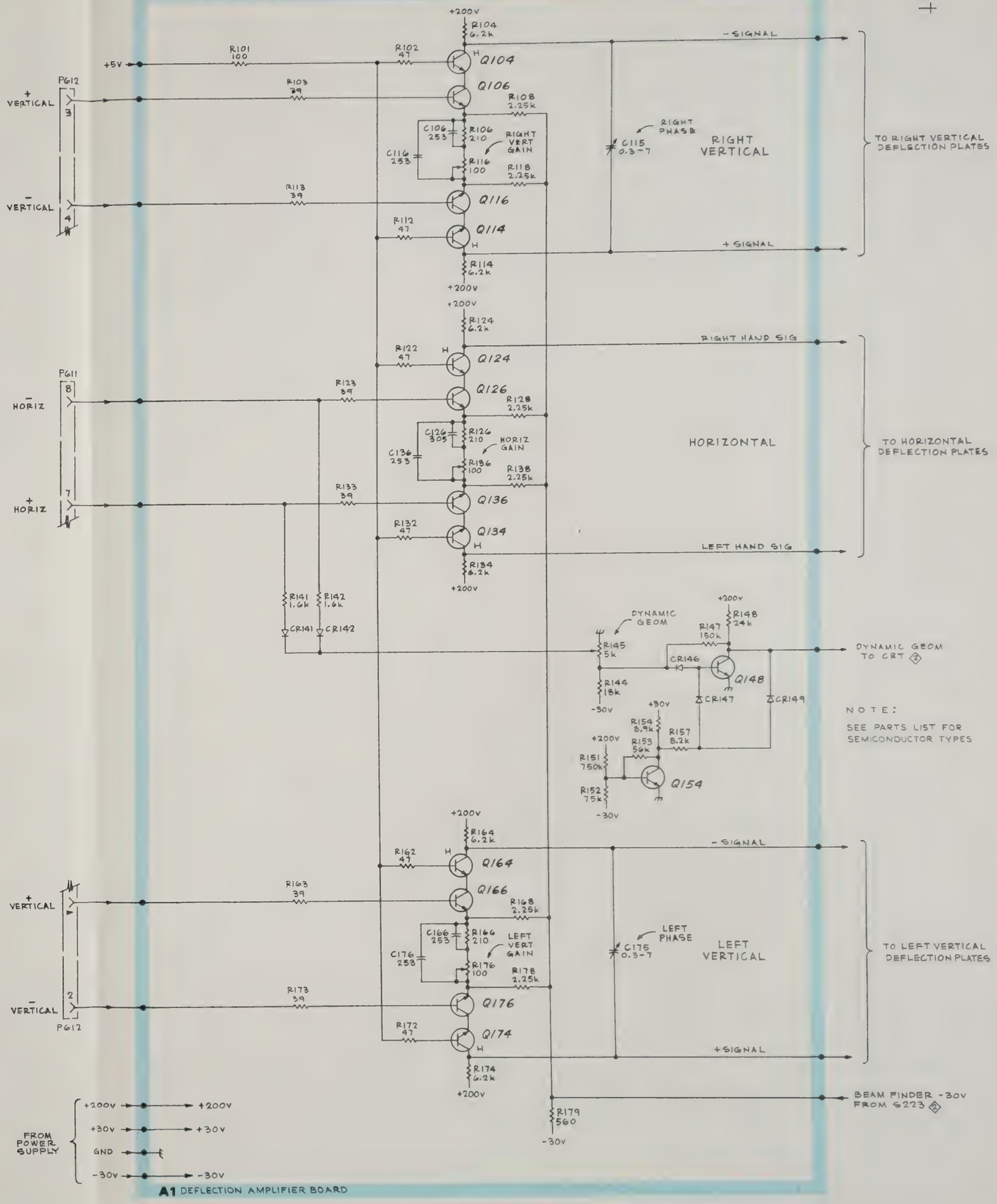
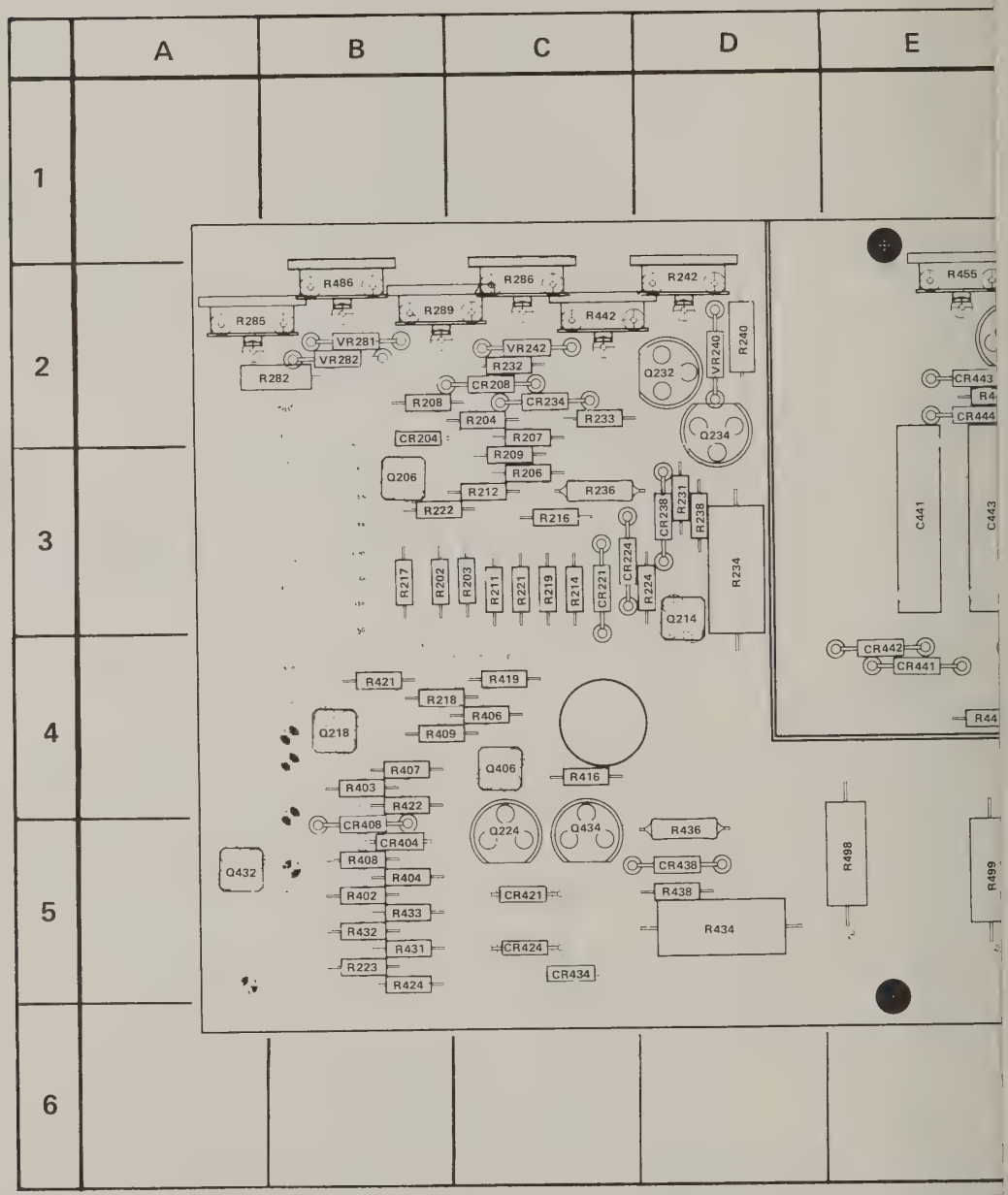


Fig. 4-2. Location of Deflection Amplifier adjustments.

Ⓐ



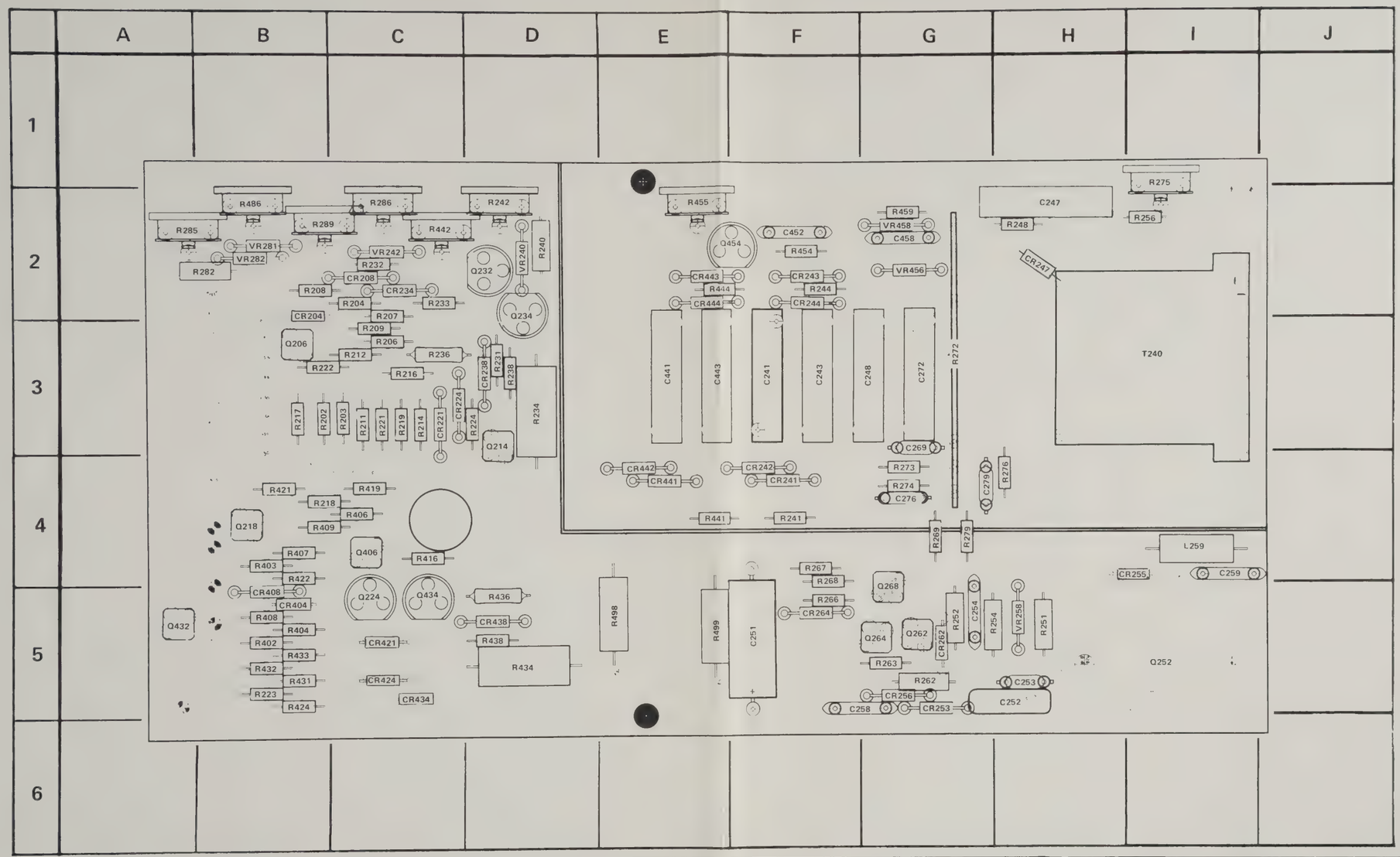
HIGH VOLTAGE BOA



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO
C241	F-3	C452	F-2	CR204	B-2	CR404	B-5	VR458	G-2	Q206
C243	F-3	C458	G-2	CR208	C-2	CR408	B-5			Q214
C247	H-2			CR221	C-3	CR421	C-5	L259	I-4	Q218
C248	G-3			CR224	C-3	CR424	C-5			Q224
C251	F-5			CR234	C-2	CR434	C-5			Q232
C252	H-5			CR238	D-3	CR438	D-5			Q234
C253	H-5			CR241	F-4	CR441	E-4			Q252
C254	G-5			CR242	F-4	CR442	E-4			Q262
C258	G-5			CR243	F-2	CR443	E-2			Q264
C259	I-4			CR244	F-2	CR444	E-2			Q268
C269	G-4			CR247	H-2	VR240	D-2			Q406
C272	G-3			CR253	G-5	VR242	C-2			Q432
C276	G-4			CR255	I-4	VR258	H-5			Q434
C279	G-4			CR256	G-5	VR281	B-2			Q454
C441	E-3			CR262	G-5	VR282	B-2			
C443	E-3			CR264	F-5	VR456	G-2			
						VR458	G-2			

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A3	*670-1503-00			HIGH VOLTAGE Circuit Board Assembly
CAPACITORS				
Tolerance ±20% unless otherwise indicated.				
C241	283-0261-00			0.01 µF, Cer, 4000 V
C243	283-0021-00			0.001 µF, Cer, 5000 V
C247	283-0261-00			0.01 µF, Cer, 4000 V
C248	283-0261-00			0.01 µF, Cer, 4000 V
C251	290-0194-00			10 µF, Elect., 100 V
C252	283-0617-00			4700 pF, Mica, 300 V, 10%
C253	283-0068-00			0.01 µF, Cer, 500 V
C254	283-0059-00			1 µF, Cer, 500 V, +80%-20%
C258	283-0059-00			1 µF, Cer, 500 V, +80%-20%
C259	283-0208-00			0.22 µF, Cer, 200 V, 10%
C264	283-0004-00	XB040000		0.2 µF, (nominal value), selected
C269	283-0198-00			0.22 µF, Cer, 50 V
C272	283-0021-00			0.001 µF, Cer, 5000 V
C276	283-0119-00	B010100	B039999X	2200 pF, Cer, 200 V, 5%
C279	283-0078-00	B010100	B039999X	0.001 µF, Cer, 500 V
C441	283-0261-00			0.01 µF, Cer, 4000 V
C443 •	283-0021-00			0.0001 µF, Cer, 5000 V
C452	283-0211-00			0.1 µF, Cer, 200 V, 10%
C458	283-0211-00			0.1 µF, Cer, 200 V, 10%
SEMICONDUCTOR DEVICE, DIODES				
CR204	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR208	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR221	152-0061-00			Silicon, replaceable by CD8393 or FHD2161
CR224	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR234	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR238	152-0061-00			Silicon, replaceable by CD8893 or FDH2161
CR241	152-0242-00			Silicon, selected from 1N486A or CD12691
CR242	152-0242-00			Silicon, selected from 1N486A or CD12691
CR243	152-0242-00			Silicon, selected from 1N486A or CD12691
CR244	152-0242-00			Silicon, selected from 1N486A or CD12691
CR247	152-0409-00			Silicon, replaceable by VG-12X
CR253	152-0414-00			Silicon, replaceable by MR812
CR255	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR256	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR262	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR264	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR404	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR408	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR421	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR424	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR434	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR438	152-0061-00			Silicon, replaceable by CD8393 or FDH2161

HIGH VOLTAGE BOARD PARTS LOCATION



CKT NO	GRID LOC
C241	F-3
C243	F-3
C247	H-2
C248	G-3
C251	F-5
C252	H-5
C253	H-5
C254	G-5
C258	G-5
C259	I-4
C269	G-4
C272	G-3
C276	G-4
C279	G-4
C441	E-3
C443	E-3
C452	F-2
C458	G-2

CKT NO	GRID LOC
CR204	B-2
CR208	C-2
CR221	C-3
CR224	C-3
CR234	C-2
CR238	D-3
CR241	F-4
CR242	F-4
CR243	F-2
CR244	F-2
CR247	H-2
CR253	G-5
CR255	I-4
CR256	G-5
CR262	G-5
CR264	F-5

CKT NO	GRID LOC
CR404	B-5
CR408	B-5
CR421	C-5
CR424	C-5
CR434	C-5
CR438	D-5
CR441	E-4
CR442	E-4
CR443	E-2
CR444	E-2
VR240	D-2
VR242	C-2
VR258	H-5
VR281	B-2
VR282	B-2
VR456	G-2
VR458	G-2

CKT NO	GRID LOC
VR458	G-2
L259	I-4

CKT NO	GRID LOC
Q206	B-3
Q214	B-3
Q218	B-4
Q224	C-5
Q232	D-2
Q234	D-2
Q252	I-5
Q262	G-5
Q264	G-5
Q268	G-5
Q406	C-4
Q432	A-5
Q434	C-5
Q454	F-2

CKT NO	GRID LOC
R202	B-3
R203	C-3
R204	C-2
R206	C-3
R207	C-2
R208	B-2
R209	C-3
R211	C-3
R212	C-3
R214	C-3
R216	C-3
R217	B-3
R218	B-4
R219	C-3
R221	C-3
R222	B-3

CKT NO	GRID LOC
R223	B-5
R224	D-3
R231	D-3
R232	C-2
R233	C-2
R234	D-3
R236	C-3
R238	D-3
R240	D-2
R241	F-4
R242	D-2
R244	F-2
R245	F-2
R248	H-2
R251	H-5
R252	G-5

CKT NO	GRID LOC
R254	H-5
R256	I-2
R262	G-5
R263	G-5
R266	F-5
R267	F-4
R268	F-4
R269	G-4
R272	G-3
R273	G-4
R274	G-4
R275	I-1
R276	H-4
R279	G-4
R282	B-2
R285	A-2

CKT NO	GRID LOC
R286	C-2
R289	B-2
R402	B-5
R403	B-4
R404	B-5
R406	C-4
R407	B-4
R408	B-5
R409	C-4
R416	C-4
R419	C-4
R421	B-4
R422	B-4
R424	B-5
R431	B-5
R432	B-5

CKT NO	GRID LOC
R433	B-5
R434	D-5
R436	D-5
R438	D-5
R441	E-4
R442	C-2
R444	E-2
R445	E-2
R454	F-2
R455	E-2
R459	G-2
R486	B-2
R498	E-5
R499	E-5
T240	I-3

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A3	*670-1503-00			HIGH VOLTAGE Circuit Board Assembly
CAPACITORS				
Tolerance ±20% unless otherwise indicated.				
C241	283-0261-00			0.01 µF, Cer, 4000 V
C243	283-0021-00			0.001 µF, Cer, 5000 V
C247	283-0261-00			0.01 µF, Cer, 4000 V
C248	283-0261-00			0.01 µF, Cer, 4000 V
C251	290-0194-00			10 µF, Elect., 100 V
C252	283-0617-00			4700 pF, Mica, 300 V, 10%
C253	283-0068-00			0.01 µF, Cer, 500 V
C254	283-0059-00			1 µF, Cer, 500 V, +80%-20%
C258	283-0059-00			1 µF, Cer, 500 V, +80%-20%
C259	283-0208-00			0.22 µF, Cer, 200 V, 10%
C264	283-0004-00	XB040000		0.2 µF, (nominal value), selected
C269	283-0198-00			0.22 µF, Cer, 50 V
C272	283-0021-00			0.001 µF, Cer, 5000 V
C276	283-0119-00	B010100	B039999X	2200 pF, Cer, 200 V, 5%
C279	283-0078-00	B010100	B039999X	0.001 µF, Cer, 500 V
C441	283-0261-00			0.01 µF, Cer, 4000 V
C443	283-0021-00			0.0001 µF, Cer, 5000 V
C452	283-0211-00			0.1 µF, Cer, 200 V, 10%
C458	283-0211-00			0.1 µF, Cer, 200 V, 10%
SEMICONDUCTOR DEVICE, DIODES				
CR204	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR208	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR221	152-0061-00			Silicon, replaceable by CD8393 or FHD2161
CR224	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR234	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR238	152-0061-00			Silicon, replaceable by CD8893 or FDH2161
CR241	152-0242-00			Silicon, selected from 1N486A or CD12691
CR242	152-0242-00			Silicon, selected from 1N486A or CD12691
CR243	152-0242-00			Silicon, selected from 1N486A or CD12691
CR244	152-0242-00			Silicon, selected from 1N486A or CD12691
CR247	152-0409-00			Silicon, replaceable by VG-12X
CR253	152-0414-00			Silicon, replaceable by MR812
CR255	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR256	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR262	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR264	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR404	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR408	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR421	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR424	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR434	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
CR438	152-0061-00			Silicon, replaceable by CD8393 or FDH2161

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
SEMICONDUCTOR DEVICE, DIODES (cont)				
CR441	152-0242-00			Silicon, selected from 1N486A or CD12691
CR442	152-0242-00			Silicon, selected from 1N486A or CD12691
CR443	152-0242-00			Silicon, selected from 1N486A or CD12691
CR444	152-0242-00			Silicon, selected from 1N486A or CD12691
VR240	152-0283-00			Zener, replaceable by 1N976B, 400 mW, 43 V, 5%
VR242	152-0283-00			Zener, replaceable by 1N976B, 400 mW, 43 V, 5%
VR258	152-0438-00			Zener, replaceable by UZ709, 3 W, 9.1 V, 5%
VR281	152-0513-00			Zener, replaceable by #HW91B, 1 W, 91 V, 5%
VR282	152-0513-00			Zener, replaceable by #HW91B, 1 W, 91 V, 5%
VR456	152-0427-00			Zener, replaceable by 1N985B, 400 mW, 100 V, 5%
VR458	152-0427-00			Zener, replaceable by 1N985B, 400 mW, 100 V, 5%
FUSES				
F201	159-0003-00			1.6 A, 3AG, Slo-Blo (Domestic)
F201	159-0019-00			1 A, 3AG, Slo-Blo (Export)
CONNECTORS				
J203	131-0955-00			Receptacle, electrical, BNC, female
J403	131-0955-00			Receptacle, electrical, BNC, female
INDUCTORS				
L259	*108-0564-00			75 μH
L291	*108-0644-00			Trace rotation
TRANSISTORS				
Q206	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q214	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q218	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q224	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q232	151-0228-00			Silicon, PNP, selected from 2N4888
Q234	151-0150-00			Silicon, NPN, replaceable by 2N3440
Q252	151-0256-00			Silicon, NPN, selected from DTS411
Q262	151-0207-00			Silicon, NPN, replaceable by 2N3415
Q264	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q268	151-1005-00			Silicon, FET, selected from 2N4303 or replaceable by U1490
Q406	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q432	151-0228-00			Silicon, PNP, selected from 2N4888
Q434	151-0150-00			Silicon, NPN, replaceable by 2N3440
Q454	151-0280-00			Silicon, PNP, replaceable by MM4003
RESISTORS				
Resistors are fixed, composition, ±10% unless otherwise indicated.				
R200A R200B	311-1176-00			100 kΩ, Var 5 MΩ,
R202	315-0563-00			56 kΩ, 1/4 W, 5%
R203	315-0103-00			10 kΩ, 1/4 W, 5%
R204	315-0623-00			62 kΩ, 1/4 W, 5%
R206	315-0103-00			10 kΩ, 1/4 W, 5%
R207	315-0153-00			15 kΩ, 1/4 W, 5%
R208	315-0103-00			10 kΩ, 1/4 W, 5%
R209	315-0183-00			18 kΩ, 1/4 W, 5%
R211	316-0104-00			100 kΩ, 1/4 W
R212	315-0103-00			10 kΩ, 1/4 W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R214	316-0104-00			100 kΩ, 1/4 W
R216	321-0285-00			9.09 kΩ, 1/8 W, Prec, 1%
R217	316-0104-00			100 kΩ, 1/4 W
R218	316-0104-00			100 kΩ, 1/4 W
R219	315-0822-00			8.2 kΩ, 1/4 W, 5%
R221	316-0823-00			82 kΩ, 1/4 W
R222	315-0563-00			56 kΩ, 1/4 W, 5%
R223	315-0103-00			10 kΩ, 1/4 W, 5%
R224	315-0333-00			33 kΩ, 1/4 W, 5%
R231	315-0564-00			560 kΩ, 1/4 W, 5%
R232	316-0102-00			1 kΩ, 1/4 W
R233	316-0682-00			6.8 k Ω, 1/4 W
R234	305-0473-00			47 kΩ, 2 W, 5%
R236	321-0399-00			140 kΩ, 1/8 W, Prec, 1%
R238	316-0101-00			100 Ω, 1/4 W
R240	302-0273-00			27 kΩ, 1/2 W
R241	316-0185-00	B010100	B029999	1.8 MΩ, 1/4 W
R241	316-0105-00	B030000		1 MΩ, 1/4 W
R242	311-1136-00			100 kΩ, Var
R244	316-0106-00			10 MΩ, 1/4 W
R245	315-0103-00			10 kΩ, 1/4 W, 5%
R248	315-0273-00			27 kΩ, 1/4 W, 5%
R251	307-0058-00			5.6 Ω, 1/2 W, 5%
R252	308-0075-00			100 Ω, 3 W, WW, 5%
R254	308-0365-00			1.5 Ω, 3 W, WW, 5%
R256	316-0102-00			1 kΩ, 1/4 W
R262	301-0472-00			4.7 kΩ, 1/2 W, 5%
R263	315-0183-00			18 kΩ, 1/4 W, 5%
R264	315-0753-00	XB040000		75 kΩ, 1/4 W, 5%
R266	315-0333-00			33 kΩ, 1/4 W, 5%
R267	315-0334-00			330 kΩ, 1/4 W, 5%
R268	315-0562-00			5.6 kΩ, 1/4 W, 5%
R269	315-0103-00			10 kΩ, 1/4 W, 5%
R272A	*307-0304-00			20 MΩ, Thick film
R272B				180 kΩ,
R272C				1.6 MΩ,
R272D				14 MΩ,
R273	316-0105-00			1 MΩ, 1/4 W
R274	316-0395-00			3.9 MΩ, 1/4 W
R275	311-1136-00			100 kΩ, Var
R276	316-0105-00			1 MΩ, 1/4 W
R279	316-0104-00	B010100	B039999X	100 kΩ, 1/4 W
R282	301-0133-00			13 kΩ, 1/2 W, 5%
R285	311-1206-00			250 kΩ, Var
R286	311-1296-00			500 kΩ, Var
R289	311-1135-00			1 MΩ, Var
R291	311-1189-00			5 kΩ, Var
R400A	311-1176-00			100 kΩ, Var
R400B				5 MΩ,
R402	315-0563-00			56 kΩ, 1/4 W, 5%
R403	315-0103-00			10 kΩ, 1/4 W, 5%
R404	315-0623-00			62 kΩ, 1/4 W, 5%
R406	315-0103-00			10 kΩ, 1/4 W, 5%
R407	315-0153-00			15 kΩ, 1/4 W, 5%
R408	315-0103-00			10 kΩ, 1/4 W, 5%

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R409	315-0183-00			18 kΩ, 1/4 W, 5%
R416	321-0285-00			9.09 kΩ, 1/8 W, Prec, 1%
R419	315-0822-00			8.2 kΩ, 1/4 W, 5%
R421	316-0823-00			82 kΩ, 1/4 W
R422	315-0563-00			56 kΩ, 1/4 W, 5%
R424	315-0333-00			33 kΩ, 1/4 W, 5%
R431	315-0564-00			560 kΩ, 1/4 W, 5%
R432	316-0102-00			1 kΩ, 1/4 W
R433	316-0682-00			6.8 kΩ, 1/4 W
R434	305-0473-00			47 kΩ, 2 W, 5%
R436	321-0399-00			140 kΩ, 1/8 W, Prec, 1%
R438	316-0101-00			100 Ω, 1/4 W
R441	316-0185-00	B010100	B029999	1.8 MΩ, 1/4 W
R441	316-0105-00	B030000		1 MΩ, 1/4W
R442	311-1136-00			100 kΩ, Var
R444	316-0106-00			10 MΩ, 1/4 W
R445	315-0103-00			10 kΩ, 1/4 W, 5%
R454	316-0472-00			4.7 kΩ, 1/4 W
R455	311-1205-00			2 MΩ, Var
R459	316-0104-00			100 kΩ, 1/4 W
R486	311-1296-00			500 kΩ, Var
R498	303-0471-00			470 Ω, 1 W, 5%
R499	303-0561-00			560 Ω, 1 W, 5%
SWITCHES				
Wired or Unwired				
S200	260-0227-00			Thermostatic, open 73.9° C, close 51.7° C
S201	260-1222-00			Push-pull, POWER
S223	260-1238-00			Push, BEAM FINDER
TRANSFORMER				
T240	*120-0706-00			HV Power
ELECTRON TUBE				
V291	*154-0635-00			CRT (D12 only)
V291	*154-0636-00			CRT (D13 only)

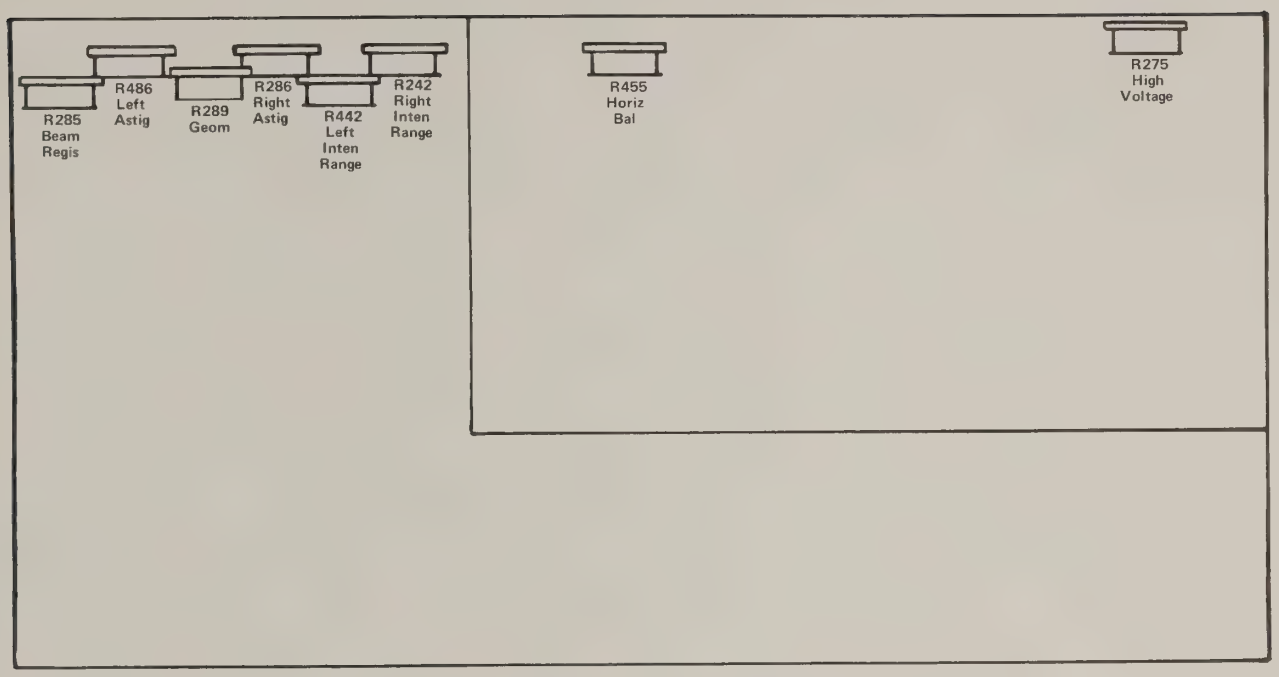


Fig. 4-4. Location of CRT Circuit adjustments.

Ⓐ

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
R409	315-0183-00			18 kΩ, 1/4 W, 5%
R416	321-0285-00			9.09 kΩ, 1/8 W, Prec, 1%
R419	315-0822-00			8.2 kΩ, 1/4 W, 5%
R421	316-0823-00			82 kΩ, 1/4 W
R422	315-0563-00			56 kΩ, 1/4 W, 5%
R424	315-0333-00			33 kΩ, 1/4 W, 5%
R431	315-0564-00			560 kΩ, 1/4 W, 5%
R432	316-0102-00			1 kΩ, 1/4 W
R433	316-0682-00			6.8 kΩ, 1/4 W
R434	305-0473-00			47 kΩ, 2 W, 5%
R436	321-0399-00			140 kΩ, 1/8 W, Prec, 1%
R438	316-0101-00			100 Ω, 1/4 W
R441	316-0185-00	B010100	B029999	1.8 MΩ, 1/4 W
R441	316-0105-00	B030000		1 MΩ, 1/4W
R442	311-1136-00			100 kΩ, Var
R444	316-0106-00			10 MΩ, 1/4 W
R445	315-0103-00			10 kΩ, 1/4 W, 5%
R454	316-0472-00			4.7 kΩ, 1/4 W
R455	311-1205-00			2 MΩ, Var
R459	316-0104-00			100 kΩ, 1/4 W
R486	311-1296-00			500 kΩ, Var
R498	303-0471-00			470 Ω, 1 W, 5%
R499	303-0561-00			560 Ω, 1 W, 5%
SWITCHES				
Wired or Unwired				
S200	260-0227-00			Thermostatic, open 73.9° C, close 51.7° C
S201	260-1222-00			Push-pull, POWER
S223	260-1238-00			Push, BEAM FINDER
TRANSFORMER				
T240	*120-0706-00			HV Power
ELECTRON TUBE				
V291	*154-0635-00			CRT (D12 only)
V291	*154-0636-00			CRT (D13 only)

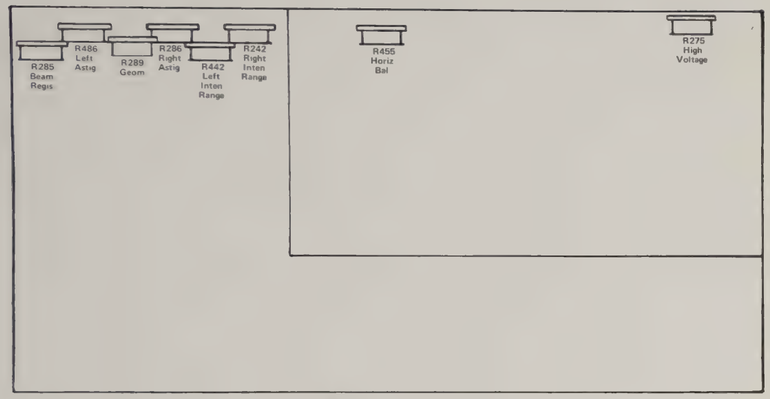
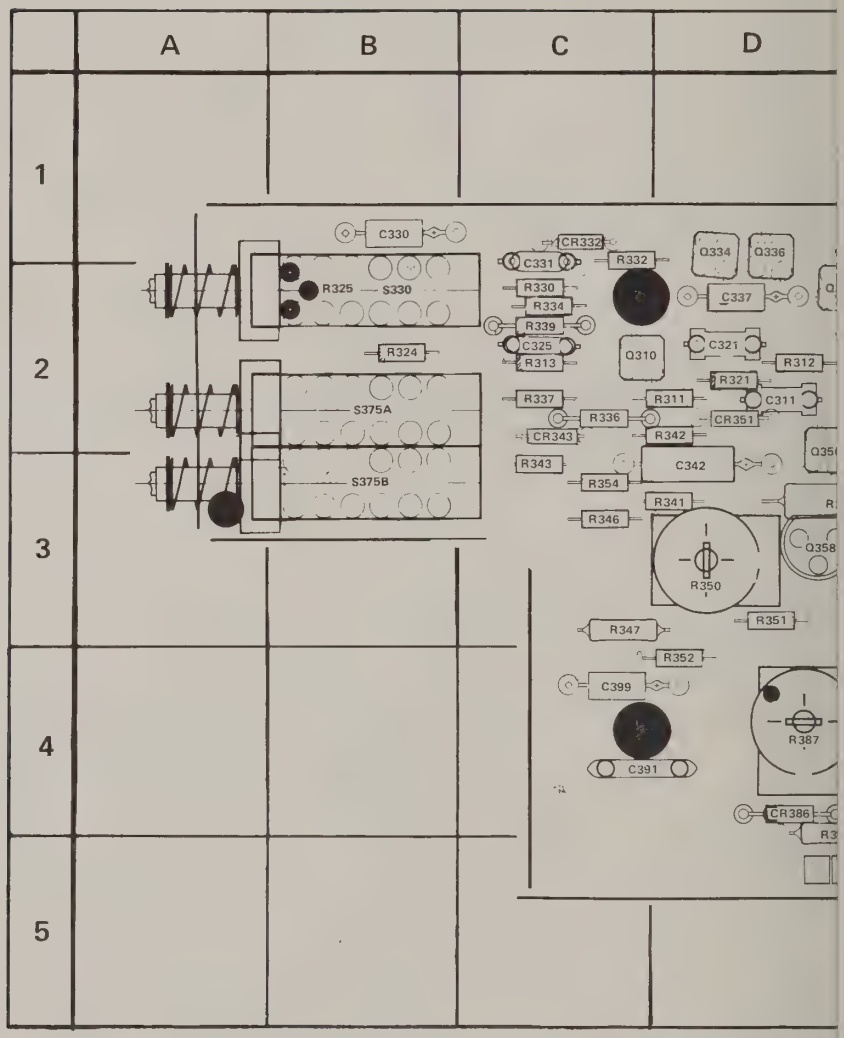


Fig. 4-4. Location of CRT Circuit adjustments.

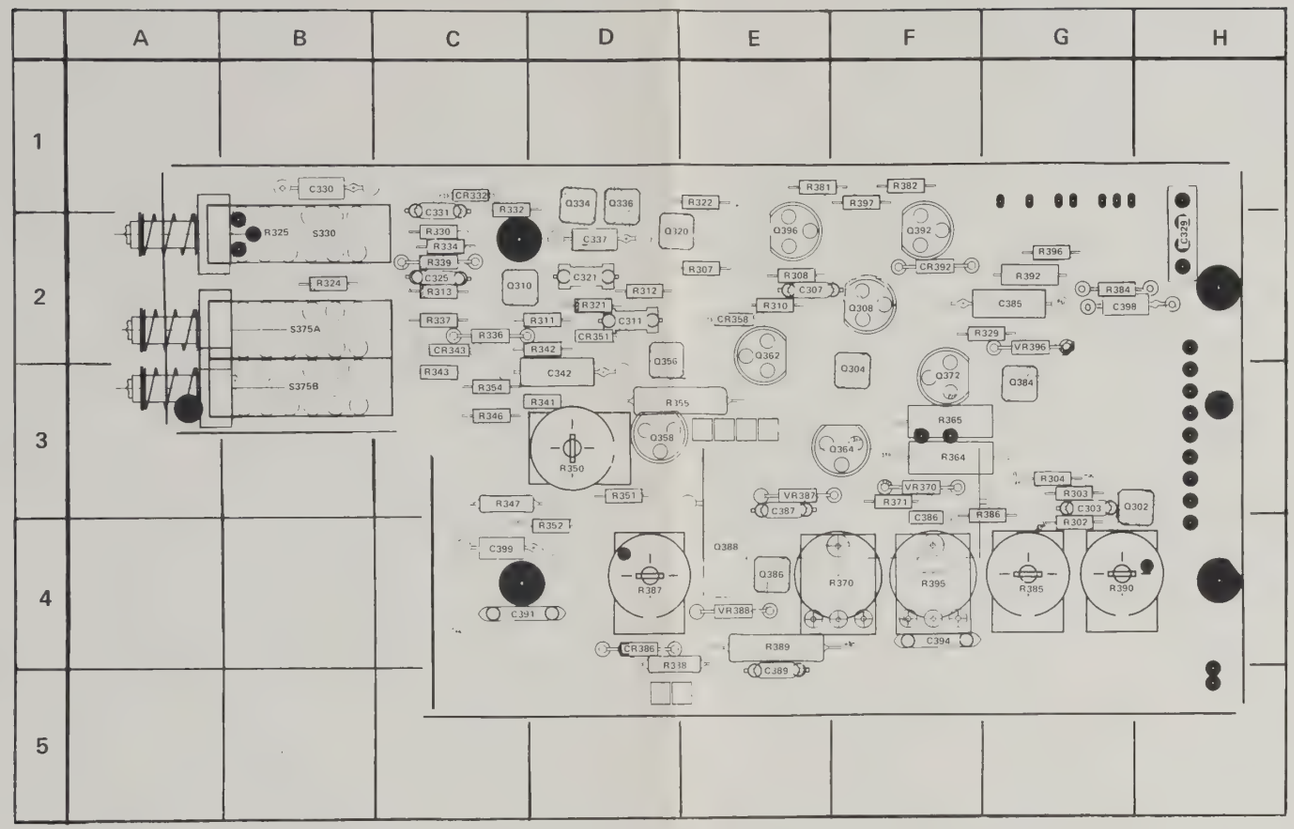
STORAGE BOARD PAR



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C303	G-3	CR329	H2	Q302	G-3
C307	E-2	CR332	C-1	Q304	F-3
C311	D-2	CR343	C-2	Q308	F-2
C321	D-2	CR351	D-2	Q310	C-2
C325	C-2	CR358	E-2	Q320	D-2
C330	B-1	CR386	D-4	Q334	D-1
C331	C-1	CR392	F-2	Q336	D-1
C337	D-2			Q356	D-2
C342	D-3	VR370	F-3	Q358	D-3
C385	G-2	VR387	E-3	Q362	E-2
C386	F-4	VR388	E-4	Q364	F-3
C387	E-3	VR396	G-2	Q372	F-3
C389	E-4			Q384	G-3
C391	C-4			Q386	E-4
C394	F-4			Q388	E-4
C398	G-2			Q392	F-2
C399	C-4			Q396	E-2

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A4	*670-1434-00			STORAGE Circuit Board Assembly (D13 only)
CAPACITORS				
Tolerance ±20% unless otherwise indicated.				
C303	283-0067-00			0.001 µF, Cer, 200 V, 10%
C307	283-0067-00			0.001 µF, Cer, 200 V, 10%
C311	281-0500-00			2.2 pF, Cer, 500 V, ±0.5 pF
C321	281-0500-00			2.2 pF, Cer, 500 V, ±0.5 pF
C325	283-0026-00			0.2 µF, Cer, 25 V
C330	290-0267-00			1 µF, Elect., 35 V
C331	283-0003-00			0.01 µF, Cer, 150 V
C337	290-0188-00			0.1 µF, Elect., 35 V, 10%
C342	290-0135-00			15 µF, Elect., 20 V
C385	290-0134-00			22 µF, Elect., 15 V
C386	285-0562-00			0.47 µF, PTM, 400 V
C387	283-0067-00			0.001 µF, Cer, 200 V, 10%
C389	283-0013-00			0.01 µF, Cer, 1000 V
C391	283-0008-00			0.1 µF, Cer, 500 V
C394	283-0057-00			0.1 µF, Cer, 200 V, +80%-20%
C398	290-0267-00			1 µF, Elect., 35 V
C399	290-0247-00			5.6 µF, Elect., 6 V
SEMICONDUCTOR DEVICE, DIODES				
CR329	152-0488-00			Silicon, rectifier bridge, 200 V, 1.5 A
CR332	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR343	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR351	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR358	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR386	152-0331-00			Silicon, rectifier, fast recovery, 800 V, 25 mA
CR392	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
VR370	152-0287-00			Zener, replaceable by 1N986B, 400 mW, 100 V, 5%
VR387	152-0283-00			Zener, replaceable by 1N976B, 400 mW, 43 V, 5%
VR388	152-0166-00			Zener, selected from 1N753A, 400 mW, 6.2 V, 5%
VR396	152-0288-00			Zener, selected from 1N988, 400 mW, 140 V, 5%
TRANSISTORS				
Q302	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q304	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q308	151-0279-00			Silicon, NPN, replaceable by SE7056
Q310	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q320	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q334	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q336	151-0207-00			Silicon, NPN, replaceable by 2N3415
Q356	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q358	151-0169-00			Silicon, NPN, replaceable by 2N3439
Q362	151-0279-00			Silicon, NPN, replaceable by SE7056
Q364	151-0279-00			Silicon, NPN, replaceable by SE7056
Q372	151-0279-00			Silicon, NPN, replaceable by SE7056
Q384	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q386	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q388	151-0331-00			Silicon, NPN, selected from D40C5 or replaceable by D40C8
Q392	151-0169-00			Silicon, NPN, replaceable by 2N3439
Q396	151-0279-00			Silicon, NPN, replaceable by SE7056

STORAGE BOARD PARTS LOCATION



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C303	G-3	CR329	H2	Q302	G-3	R302	G-4	R343	C-3	R395	F-4
C307	E-2	CR332	C-1	Q304	F-3	R303	G-3	R346	C-3	R396	G-2
C311	D-2	CR343	C-2	Q308	F-2	R304	G-3	R347	C-3	R397	F-1
C321	D-2	CR351	D-2	Q310	C-2	R307	E-2	R350	D-3		
C325	C-2	CR358	E-2	Q320	D-2	R308	E-2	R351	D-3		
C330	B-1	CR386	D-4	Q334	D-1	R310	E-2	R352	D-4		
C331	C-1	CR392	F-2	Q336	D-1	R311	D-2	R354	C-3		
C337	D-2			Q356	D-2	R312	D-2	R355	D-3		
C342	D-3	VR370	F-3	Q358	D-3	R313	C-2	R364	F-3		
C385	G-2	VR387	E-3	Q362	E-2	R321	D-2	R365	F-3		
C386	F-4	VR388	E-4	Q364	F-3	R322	E-1	R370	F-4		
C387	E-3	VR396	G-2	Q372	F-3	R324	B-2	R371	F-3		
C389	E-4			Q384	G-3	R325	B-2	R381	E-1		
C391	C-4			Q386	E-4	R329	G-2	R382	F-1		
C394	F-4			Q388	E-4	R330	C-2	R384	G-2		
C398	G-2			Q392	F-2	R332	C-1	R385	G-4		
C399	C-4			Q396	E-2	R334	C-2	R386	G-4		
						R336	C-2	R387	D-4		
						R337	C-2	R388	D-4		
						R339	C-2	R389	E-4		
						R341	D-3	R390	G-4		
						R342	D-2	R392	G-2		

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A4	*670-1434-00			STORAGE Circuit Board Assembly (D13 only)
CAPACITORS				
Tolerance ±20% unless otherwise indicated.				
C303	283-0067-00			0.001 µF, Cer, 200 V, 10%
C307	283-0067-00			0.001 µF, Cer, 200 V, 10%
C311	281-0500-00			2.2 pF, Cer, 500 V, ±0.5 pF
C321	281-0500-00			2.2 pF, Cer, 500 V, ±0.5 pF
C325	283-0026-00			0.2 µF, Cer, 25 V
C330	290-0267-00			1 µF, Elect., 35 V
C331	283-0003-00			0.01 µF, Cer, 150 V
C337	290-0188-00			0.1 µF, Elect., 35 V, 10%
C342	290-0135-00			15 µF, Elect., 20 V
C385	290-0134-00			22 µF, Elect., 15 V
C386	285-0562-00			0.47 µF, PTM, 400 V
C387	283-0067-00			0.001 µF, Cer, 200 V, 10%
C389	283-0013-00			0.01 µF, Cer, 1000 V
C391	283-0008-00			0.1 µF, Cer, 500 V
C394	283-0057-00			0.1 µF, Cer, 200 V, +80%-20%
C398	290-0267-00			1 µF, Elect., 35 V
C399	290-0247-00			5.6 µF, Elect., 6 V
SEMICONDUCTOR DEVICE, DIODES				
CR329	152-0488-00			Silicon, rectifier bridge, 200 V, 1.5 A
CR332	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR343	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR351	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR358	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR386	152-0331-00			Silicon, rectifier, fast recovery, 800 V, 25 mA
CR392	152-0061-00			Silicon, replaceable by CD8393 or FDH2161
VR370	152-0287-00			Zener, replaceable by 1N986B, 400 mW, 100 V, 5%
VR387	152-0283-00			Zener, replaceable by 1N976B, 400 mW, 43 V, 5%
VR388	152-0166-00			Zener, selected from 1N753A, 400 mW, 6.2 V, 5%
VR396	152-0288-00			Zener, selected from 1N988, 400 mW, 140 V, 5%
TRANSISTORS				
Q302	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q304	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q308	151-0279-00			Silicon, NPN, replaceable by SE7056
Q310	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q320	151-0188-00			Silicon, PNP, replaceable by 2N3906
Q334	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q336	151-0207-00			Silicon, NPN, replaceable by 2N3415
Q356	151-0341-00			Silicon, NPN, replaceable by 2N3565
Q358	151-0169-00			Silicon, NPN, replaceable by 2N3439
Q362	151-0279-00			Silicon, NPN, replaceable by SE7056
Q364	151-0279-00			Silicon, NPN, replaceable by SE7056
Q372	151-0279-00			Silicon, NPN, replaceable by SE7056
Q384	151-0216-00			Silicon, PNP, replaceable by MPS6523
Q386	151-0342-00			Silicon, PNP, replaceable by 2N4249
Q388	151-0331-00			Silicon, NPN, selected from D40C5 or replaceable by D40C8
Q392	151-0169-00			Silicon, NPN, replaceable by 2N3439
Q396	151-0279-00			Silicon, NPN, replaceable by SE7056

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
Resistors are fixed, composition, ±10% unless otherwise indicated.				
R302	316-0102-00			1 kΩ, 1/4 W
R303	315-0513-00			51 kΩ, 1/4 W, 5%
R304	316-0474-00			470 kΩ, 1/4 W
R307	315-0223-00			22 kΩ, 1/4 W, 5%
R308	315-0103-00			10 kΩ, 1/4 W, 5%
R310	315-0223-00			22 kΩ, 1/4 W, 5%
R311	315-0125-00			1.2 MΩ, 1/4 W, 5%
R312	315-0104-00			100 kΩ, 1/4 W, 5%
R313	315-0202-00			2 kΩ, 1/4 W, 5%
R321	315-0125-00			1.2 MΩ, 1/4 W, 5%
R322	315-0104-00			100 kΩ, 1/4 W, 5%
R324	315-0243-00			24 kΩ, 1/4 W, 5%
R325	311-1155-00			20 kΩ, Var
R329	315-0104-00			100 kΩ, 1/4 W, 5%
R330	316-0105-00			1 MΩ, 1/4 W
R332	315-0201-00			200 Ω, 1/4 W, 5%
R334	316-0472-00			4.7 kΩ, 1/4 W
R336	315-0512-00			5.1 kΩ, 1/4 W, 5%
R337	315-0103-00			10 kΩ, 1/4 W, 5%
R339	315-0623-00			62 kΩ, 1/4 W, 5%
R341	315-0753-00			75 kΩ, 1/4 W, 5%
R342	316-0101-00			100 Ω, 1/4 W
R343	316-0473-00			47 kΩ, 1/4 W
R346	315-0183-00			18 kΩ, 1/4 W, 5%
R347	321-0359-00			53.6 kΩ, 1/8 W, Prec, 1%
R350	311-1153-00			5 kΩ, Var
R351	315-0203-00			20 kΩ, 1/4 W, 5%
R352	315-0103-00			10 kΩ, 1/4 W, 5%
R354	315-0154-00			150 kΩ, 1/4 W, 5%
R355	323-0452-00			499 kΩ, 1/2 W, Prec, 1%
R364	303-0473-00			47 kΩ, 1 W, 5%
R365	303-0473-00			47 kΩ, 1 W, 5%
R370	311-1166-00			250 kΩ, Var
R371	316-0393-00			39 kΩ, 1/4 W
R381	316-0334-00			330 kΩ, 1/4 W
R382	316-0334-00			330 kΩ, 1/4 W
R384	316-0123-00			12 kΩ, 1/4 W
R385	311-1153-00			5 kΩ, Var
R386	315-0100-00			10 Ω, 1/4 W, 5%
R387	311-1154-00			1 kΩ, Var
R388	321-0261-00			5.11 kΩ, 1/8 W, Prec, 1%
R389	323-0436-00			340 kΩ, 1/2 W, Prec, 1%
R390	311-1166-00			250 kΩ, Var
R392	301-0753-00			75 kΩ, 1/2 W, 5%
R395	311-1152-00			100 kΩ, Var
R396	315-0623-00			62 kΩ, 1/4 W, 5%
R397	316-0101-00			100 Ω, 1/4 W
SWITCHES				
Wired or Unwired				
S330	260-1223-00			Pushbutton, ERASE
S372A, S372B	260-1232-00			Pushbutton, UPPER, LOWER, (ERASE SELECT)
S375A, S375B	260-1207-00			Pushbutton, UPPER, LOWER, (STORE)

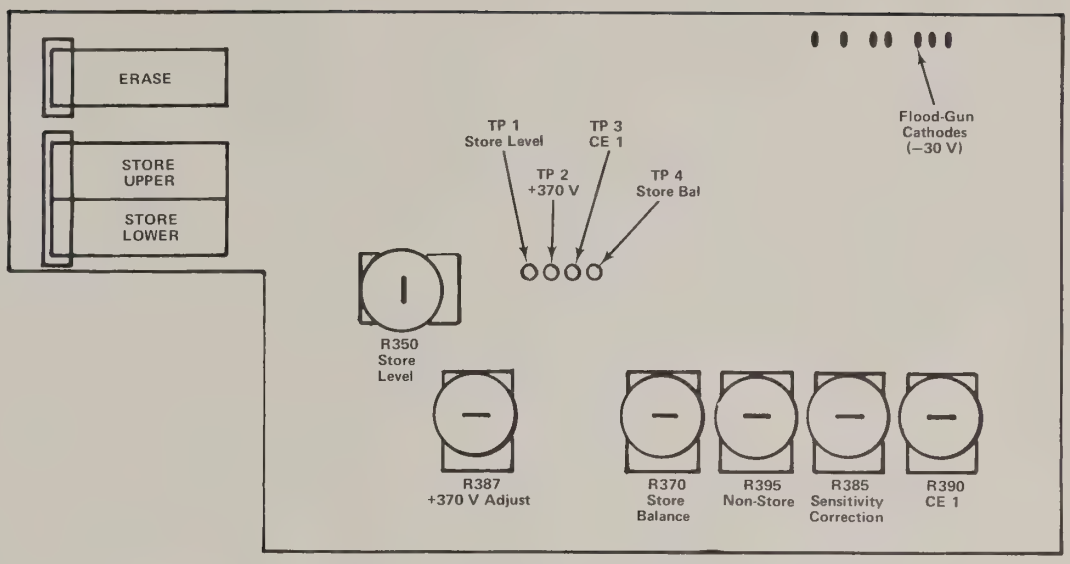


Fig. 4-6. Location of Storage Circuit adjustments and test points.

Ⓐ

Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
RESISTORS (cont)				
Resistors are fixed, composition, ±10% unless otherwise indicated.				
R302	316-0102-00			1 kΩ, 1/4 W
R303	315-0513-00			51 kΩ, 1/4 W, 5%
R304	316-0474-00			470 kΩ, 1/4 W
R307	315-0223-00			22 kΩ, 1/4 W, 5%
R308	315-0103-00			10 kΩ, 1/4 W, 5%
R310	315-0223-00			22 kΩ, 1/4 W, 5%
R311	315-0125-00			1.2 MΩ, 1/4 W, 5%
R312	315-0104-00			100 kΩ, 1/4 W, 5%
R313	315-0202-00			2 kΩ, 1/4 W, 5%
R321	315-0125-00			1.2 MΩ, 1/4 W, 5%
R322	315-0104-00			100 kΩ, 1/4 W, 5%
R324	315-0243-00			24 kΩ, 1/4 W, 5%
R325	311-1155-00			20 kΩ, Var
R329	315-0104-00			100 kΩ, 1/4 W, 5%
R330	316-0105-00			1 MΩ, 1/4 W
R332	315-0201-00			200 Ω, 1/4 W, 5%
R334	316-0472-00			4.7 kΩ, 1/4 W
R336	315-0512-00			5.1 kΩ, 1/4 W, 5%
R337	315-0103-00			10 kΩ, 1/4 W, 5%
R339	315-0623-00			62 kΩ, 1/4 W, 5%
R341	315-0753-00			75 kΩ, 1/4 W, 5%
R342	316-0101-00			100 Ω, 1/4 W
R343	316-0473-00			47 kΩ, 1/4 W
R346	315-0183-00			18 kΩ, 1/4 W, 5%
R347	321-0359-00			53.6 kΩ, 1/8 W, Prec, 1%
R350	311-1153-00			5 kΩ, Var
R351	315-0203-00			20 kΩ, 1/4 W, 5%
R352	315-0103-00			10 kΩ, 1/4 W, 5%
R354	315-0154-00			150 kΩ, 1/4 W, 5%
R355	323-0452-00			499 kΩ, 1/2 W, Prec, 1%
R364	303-0473-00			47 kΩ, 1 W, 5%
R365	303-0473-00			47 kΩ, 1 W, 5%
R370	311-1166-00			250 kΩ, Var
R371	316-0393-00			39 kΩ, 1/4 W
R381	316-0334-00			330 kΩ, 1/4 W
R382	316-0334-00			330 kΩ, 1/4 W
R384	316-0123-00			12 kΩ, 1/4 W
R385	311-1153-00			5 kΩ, Var
R386	315-0100-00			10 Ω, 1/4 W, 5%
R387	311-1154-00			1 kΩ, Var
R388	321-0261-00			5.11 kΩ, 1/8 W, Prec, 1%
R389	323-0436-00			340 kΩ, 1/2 W, Prec, 1%
R390	311-1166-00			250 kΩ, Var
R392	301-0753-00			75 kΩ, 1/2 W, 5%
R395	311-1152-00			100 kΩ, Var
R396	315-0623-00			62 kΩ, 1/4 W, 5%
R397	316-0101-00			100 Ω, 1/4 W
SWITCHES				
Wired or Unwired				
S330	260-1223-00			Pushbutton, ERASE
S372A, S372B	260-1232-00			Pushbutton, UPPER, LOWER, (ERASE SELECT)
S375A, S375B	260-1207-00			Pushbutton, UPPER, LOWER, (STORE)

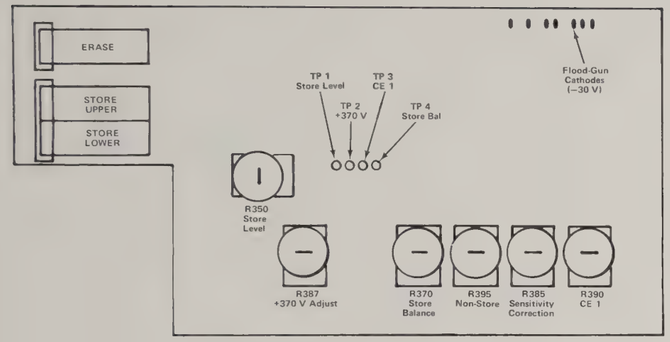
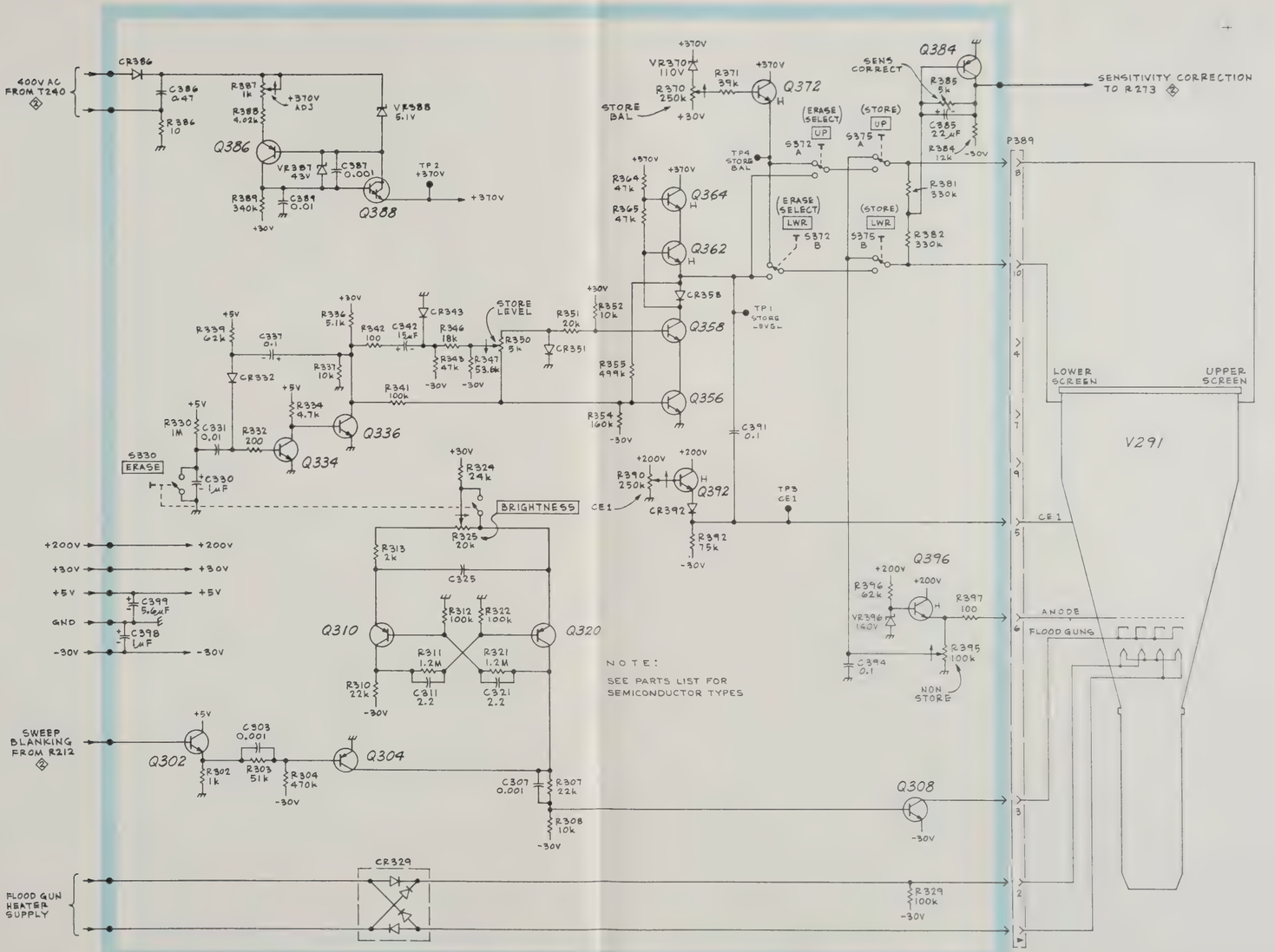
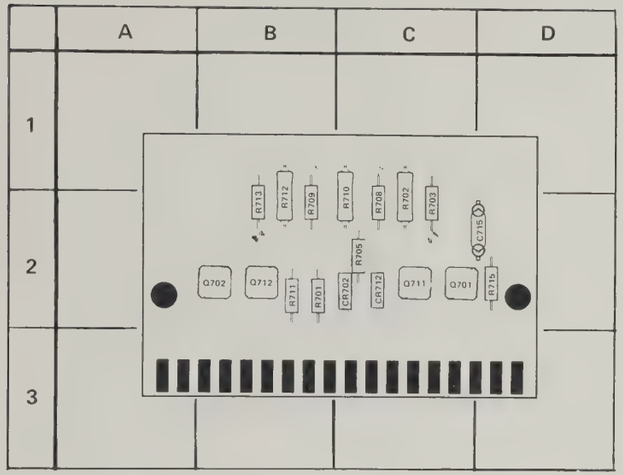


Fig. 4-6. Location of Storage Circuit adjustments and test points.



Ckt. No.	Tektronix Part No.	Serial/Model No. Eff	Disc	Description
ASSEMBLY				
A2	*670-1453-00			DUAL BEAM AUXILIARY Circuit Board Assembly
CAPACITOR				
Tolerance ±20% unless otherwise indicated.				
C715	283-0000-00			0.001 μF, Cer, 500 V
SEMICONDUCTOR DEVICE, DIODES				
CR702	152-0185-00			Silicon, selected from 1N4152 or 1N3605
CR712	152-0185-00			Silicon, selected from 1N4152 or 1N3605
TRANSISTORS				
Q701	151-0192-00			Silicon, NPN, selected from MPS6521
Q702	151-0220-00			Silicon, PNP, replaceable by 2N4122
Q711	151-0192-00			Silicon, NPN, selected from MPS6521
Q712	151-0220-00			Silicon, PNP, replaceable by 2N4122
RESISTORS				
Resistors are fixed, composition, ±10% unless otherwise indicated.				
R701	315-0393-00			39 kΩ, 1/4 W, 5%
R702	321-0222-00			2 kΩ, 1/8 W, Prec, 1%
R703	315-0822-00			8.2 kΩ, 1/4 W, 5%
R705	316-0103-00			10 kΩ, 1/4 W
R708	315-0273-00			27 kΩ, 1/4 W, 5%
R709	315-0273-00			27 kΩ, 1/4 W, 5%
R710	321-0159-00			442 Ω, 1/8 W, Prec, 1%
R711	315-0393-00			39 kΩ, 1/4 W, 5%
R712	321-0222-00			2 kΩ, 1/8 W, Prec, 1%
R713	315-0822-00			8.2 kΩ, 1/4 W, 5%
R715	316-0101-00			100 Ω, 1/4 W

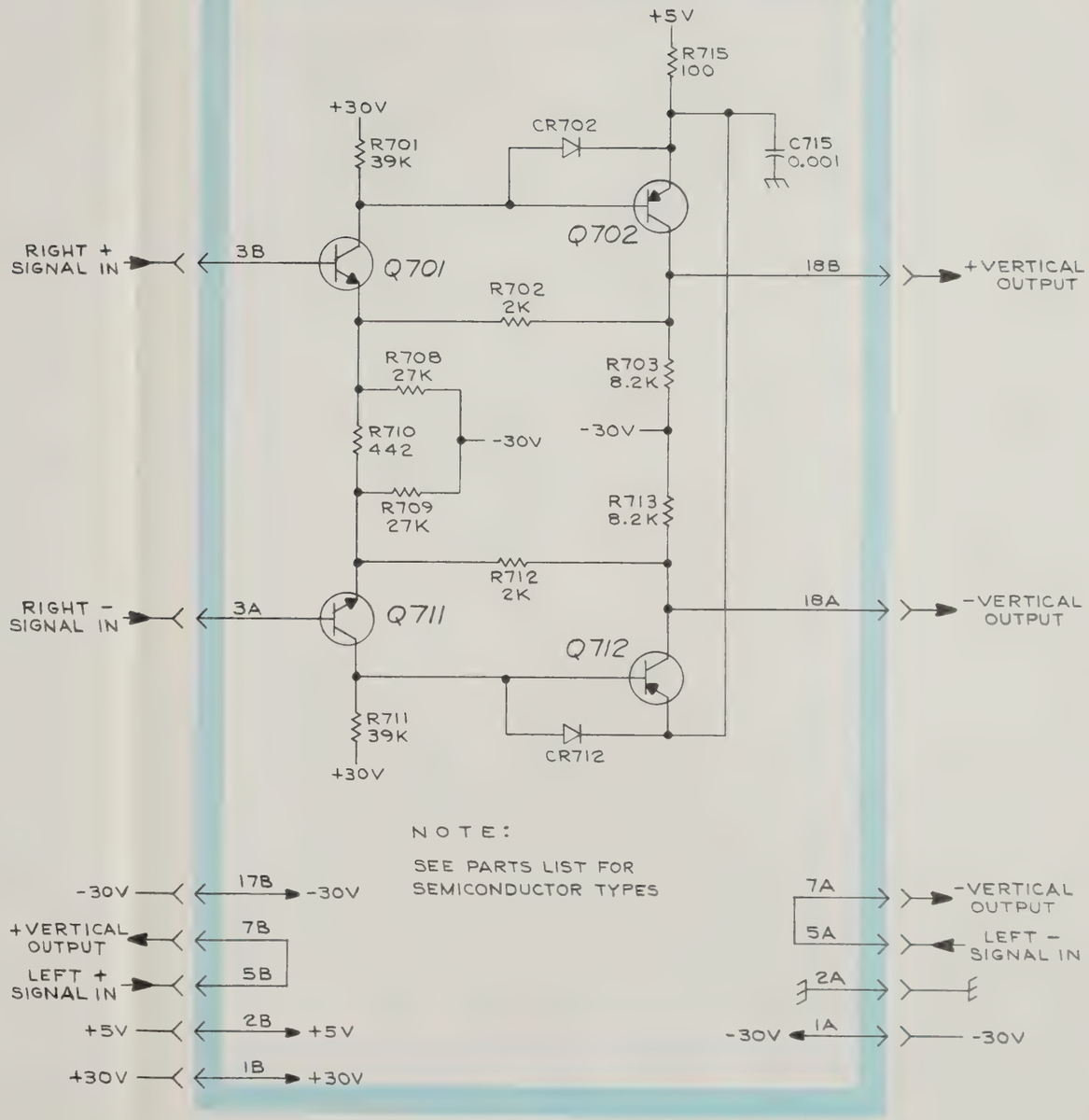
AUXILIARY BOARD PARTS LOCATION



CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC	CKT NO	GRID LOC
C715	D-2	CR702	C-2	Q701	C-2	R701	B-2
		CR712	C-2	Q702	B-2	R702	C-2
				Q711	C-2	R703	C-2
				Q712	B-2	R705	C-2
						R708	C-2
						R709	B-2
						R710	C-2
						R711	B-2
						R712	B-2
						R713	B-2
						R715	D-2

Ⓐ

A2 AUXILIARY BOARD



MECHANICAL PARTS LIST

FIGURE 1 EXPLODED

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-1	670-1453-00			1		CIRCUIT BOARD ASSEMBLY--AUXILIARY A2
	- - - - - -			-		circuit board assembly includes:
	388-2002-00			1		CIRCUIT BOARD
-2	200-1218-00			1		BEZEL
	- - - - - -			-		bezel includes:
-3	211-0188-00			2		SCREW, 4-40 x 0.70 inch
-4	354-0233-00			2		RING, retaining, 0.10 ID x 0.203 inch OD
-5	337-1440-00			1		SHIELD, implosion
-6	386-1946-00			1		SUPPORT, CRT, front
-7	348-0279-00			2		PAD, cushioning, CRT
-8	348-0070-01			3		CUSHION, CRT, 0.69 x 2.03 inches long
-9	348-0145-00			1		GROMMET, plastic, U-shape, 1 inch
-10	334-1379-00			1		LABEL, CRT, 0.75 x 1.75 inches
-11	252-0562-00			ft		PLASTIC CHANNEL, 0.418 foot long
-12	337-1447-00			1		SHIELD, CRT, front
	- - - - - -			-		mounting hardware: (not included w/shield)
-13	211-0587-00			1		SCREW, 6-32 x 0.188, HHB
-14	337-1445-00			1		SHIELD, CRT, rear
-15	407-0931-00			1		BRACKET, CRT shield
	- - - - - -			-		mounting hardware: (not included w/bracket)
-16	211-0590-00			3		SCREW, 6-32 x 0.25 inch
-17	211-0507-00			2		SCREW, 6-32 x 0.312 inch, PHS
-18	220-0419-00			5		NUT, square, 6-32 x 0.312 inch
-19	384-1064-00			1		SHAFT, extension, 10.185 inches long, w/knob
-20	119-0238-00			1		CURRENT LOOP
	- - - - - -			-		mounting hardware: (not included w/current loop)
	210-0442-00			2		NUT, hex., 3-48 x 0.188 inch
	210-0004-00			2		WASHER, lock, internal, 0.12 ID x 0.26 inch OD
	210-0994-00			2		WASHER, flat, 0.125 ID x 0.25 inch OD
	210-0935-00			2		WASHER, fiber, 0.14 ID x 0.375 inch OD
-21	361-0059-01			1		SPACER, current loop
-22	210-0593-00			2		NUT, current loop, 3-48 x 0.25 inch
-23	358-0216-00			1		BUSHING, 0.275 x 0.412 inch OD
-24	366-1326-00			2		KNOB, light gray--FOCUS
	- - - - - -			-		each knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS
-25	366-1327-00			2		KNOB, dark gray--INTENSITY
	- - - - - -			-		each knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HSS

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-26	260-1238-00			1		SWITCH, pushbutton--BEAM FINDER, w/hardware
-27	- - - - - -			2		RESISTOR, variable
	- - - - - -			-		mounting hardware for each: (not included w/resistor)
-28	210-0583-00			1		NUT, hex., 0.25-32 x 0.312 inch
-29	210-0940-00			1		WASHER, flat, 0.25 ID x 0.375 inch OD
-30	210-0046-00			1		WASHER, lock, internal, 0.261 ID x 0.40 inch OD
-31	200-0608-00			2		COVER, variable resistor, plastic
-32	333-1440-00[1]			1		PANEL, front
-33	337-1446-00			1		SHIELD, high voltage
	- - - - - -			-		mounting hardware: (not included w/shield)
-34	211-0504-00			4		SCREW, 6-32 x 0.25 inch, PHS
-35	348-0115-00			2		GROMMET, plastic, U-shape, 0.548 inch
-36	407-0896-00			1		BRACKET, chassis
	- - - - - -			-		mounting hardware: (not included w/bracket)
-37	211-0541-00			1		SCREW, 6-32 x 0.25 inch, 100° csk, FHS
-38	260-1222-00			1		SWITCH, push-pull--POWER
-39	376-0127-00			1		COUPLER, shaft, plastic
-40	- - - - - -			1		RESISTOR, variable
	- - - - - -			-		mounting hardware: (not included w/resistor)
-41	210-0590-00			1		NUT, hex., 0.375-32 x 0.438 inch
-42	210-0978-00			1		WASHER, flat, 0.375 ID x 0.50 inch OD
	210-0012-00			1		WASHER, lock, internal, 0.375 ID x 0.50 inch OD
-43	200-1204-01			1		COVER, CRT
	- - - - - -			-		mounting hardware: (not included w/cover)
-44	210-0401-00			2		NUT, cap, hex., 6-32 x 0.312 inch
-45	161-0033-08			1		CABLE ASSEMBLY, power, w/terminal
-46	358-0366-00			1		BUSHING, strain relief, bottom
	358-0365-00			1		BUSHING, strain relief, top
-47	200-1004-00			1		CABLE NIPPLE, 1.30 inches long
-48	352-0076-00			1		FUSEHOLDER, w/hardware
	- - - - - -			-		mounting hardware: (not included w/holder)
-49	210-0873-00			1		WASHER, rubber, 0.50 ID x 0.688 inch OD
-50	210-0201-00			1		LUG, solder, SE #6
	- - - - - -			-		mounting hardware: (not included w/lug)
-51	210-0586-00			1		NUT, keps, 4-40 x 0.25 inch

[1]D12 only

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-52	333-1448-00[1]			1		PANEL, rear
-53	441-1009-00			1		CHASSIS, main
	- - - - - -			-		chassis includes:
-54	210-0659-01			4		EYELET
-55	344-0131-00			4		CLIP, circuit board
	- - - - - -			-		mounting hardware: (not included w/chassis)
-56	211-0504-00			2		SCREW, 6-32 x 0.25 inch, PHS
-57	211-0538-00			2		SCREW, 6-32 x 0.312 inch, 100°csk, FHS
-58	210-0457-00			2		NUT, keps, 6-32 x 0.312 inch
-59	- - - - - -			1		SWITCH, thermostatic
	- - - - - -			-		mounting hardware: (not included w/switch)
-60	210-0586-00			2		NUT, keps, 4-40 x 0.25 inch
-61	343-0088-00			5		CLAMP, cable, plastic, push-on, small
	343-0213-00			1		CLAMP, cable, plastic, push-on, medium
-62	348-0067-00			1		GROMMET, plastic, 0.312 inch diameter
-63	348-0150-00			2		GROMMET, plastic, U-shape, 0.66 inch
-64	670-1503-00			1		CIRCUIT BOARD ASSEMBLY--HIGH VOLTAGE A3
	- - - - - -			-		circuit board assembly includes:
	388-2056-00			1		CIRCUIT BOARD
-65	136-0183-00			5		SOCKET, transistor, 3 pin
-66	136-0220-00			8		SOCKET, transistor, 3 pin, square
-67	136-0254-00			2		SOCKET, pin connector
-68	131-0589-00			2		TERMINAL, pin, 0.50 inch long
-69	131-0621-00			15		CONNECTOR, terminal
-70	214-0579-00			1		PIN, test point
-71	175-0855-00			ft		WIRE, electrical, 10 wire ribbon, 10.50 inches long
-72	175-0860-00			ft		WIRE, electrical, 5 wire ribbon, 11.50 inches long
-73	352-0202-00			1		HOLDER, terminal connector, 6 wire (black)
-74	352-0206-00			1		HOLDER, terminal connector, 10 wire (black)
-75	- - - - - -			1		TRANSISTOR
	- - - - - -			-		mounting hardware: (not included w/transistor)
-76	211-0511-00			2		SCREW, 6-32 x 0.50 inch, PHS
-77	214-1536-00			1		HEATSINK
-78	210-1133-00			2		WASHER, flat, 0.14 ID x 0.281 inch OD
-79	214-1610-00			1		HEATSINK, ceramic
-80	210-0055-00			2		WASHER, lock, split, 0.145 ID x 0.253 inch OD
-81	210-0407-00			2		NUT, hex., 6-32 x 0.25 inch
	- - - - - -			-		mounting hardware: (not included w/circuit board assembly)
-82	211-0510-00			1		SCREW, 6-32 x 0.375 inch, PHS
-83	210-0975-00			1		WASHER, plastic, 0.14 ID x 0.375 inch OD
-84	131-0955-00			2		CONNECTOR, receptacle, female, BNC, w/hardware
	- - - - - -			-		mounting hardware for each: (not included w/connector)
-85	210-0255-00			1		LUG, solder, 0.375 inch, SE

[1]D12 only

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-86	367-0154-00			1		PULL, CRT socket
-87	200-0869-00			1		COVER, CRT socket
-88	136-0469-00			1		WIRING HARNESS, CRT
	- - - - - -			-		wiring harness includes:
-89	136-0358-00			1		SOCKET, CRT
-90	441-1010-00			1		CHASSIS, deflection
	- - - - - -			-		mounting hardware: (not included w/chassis)
-91	211-0541-00			1		SCREW, 6-32 x 0.25 inch, 100° csk, FHS
-92	211-0504-00			2		SCREW, 6-32 x 0.25 inch, PHS
-93	670-1508-00	B010100	B049999	1		CIRCUIT BOARD ASSEMBLY--DEFLECTION A1
	670-1508-01	B050000		1		CIRCUIT BOARD ASSEMBLY--DEFLECTION A1
	- - - - - -			-		circuit board assembly includes:
	388-2062-00			1		CIRCUIT BOARD
-94	131-0566-00			6		LINK, terminal connecting
-95	131-0621-00			6		CONNECTOR, terminal
-96	136-0183-00	B010100	B049999	7		SOCKET, transistor, 3 pin
-97	136-0220-00	B010100	B049999	7		SOCKET, transistor, 3 pin, square
	136-0252-04	B050000		42		SOCKET, pin connector
-98	214-1291-00			6		HEATSINK, transistor
-99	337-1179-00			2		SHIELD, electrical
-100	175-0829-00			ft		WIRE, electrical, 6 wire ribbon, 10 inches long
-101	175-0860-00			ft		WIRE, electrical, 5 wire ribbon, 17.75 inches long
-102	175-0863-00			ft		WIRE, electrical, 2 wire ribbon, 18 inches long
-103	152-0198-00			1		HOLDER, terminal connector, 2 wire (black)
-104	352-0200-00			1		HOLDER, terminal connector, 4 wire (black)
	- - - - - -			-		mounting hardware: (not included w/circuit board assembly)
-105	211-0008-00			4		SCREW, 4-40 x 0.25 inch, PHS
-106	426-0767-00[1]			1		FRAME ASSEMBLY
-107	348-0063-00			1		GROMMET, plastic, 0.50 inch diameter
-108	175-0861-00			ft		WIRE, electrical, 4 wire ribbon
-109	175-0862-00			ft		WIRE, electrical, 3 wire ribbon
-110	175-0863-00			ft		WIRE, electrical, 2 wire ribbon
-111	200-1075-00			4		COVER, terminal
-112	131-0861-00			3		TERMINAL, quick disconnect
-113	131-0865-00			7		TERMINAL, pin, S-pin, male
-114	131-0621-00			2		CONNECTOR, terminal
	131-0371-00			2		CONNECTOR, terminal
-115	131-0707-00			2		CONNECTOR, terminal
-116	352-0161-00			1		HOLDER, terminal connector, 3 wire (black)
-117	352-0198-00			1		HOLDER, terminal connector, 2 wire (black)

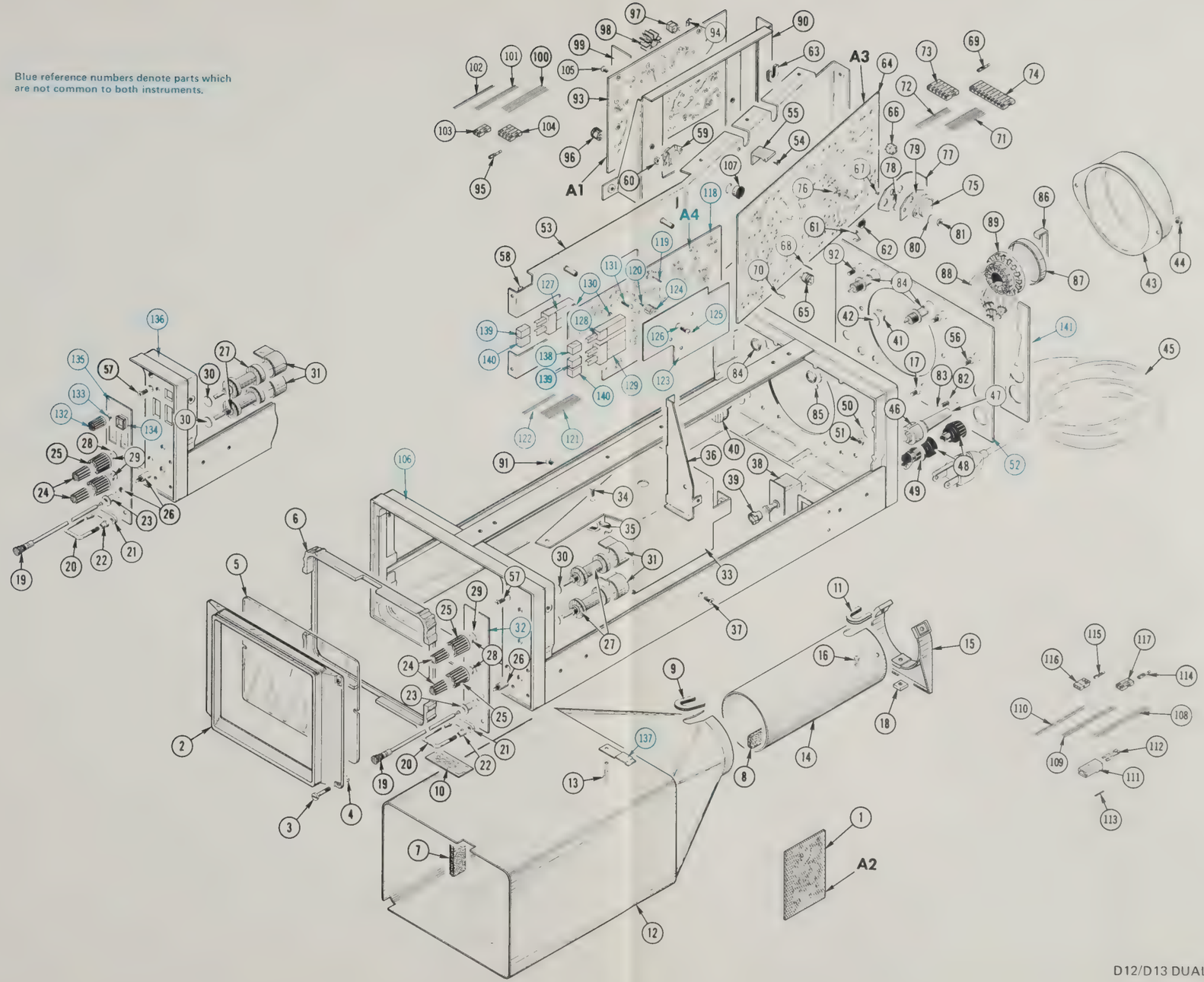
[1] D12 only

FIGURE 1 EXPLODED (cont)

Fig. & Index No.	Tektronix Part No.	Serial/Model No. Eff	Serial/Model No. Disc	Qty	1 2 3 4 5	Description
1-118	670-1434-00[1]			1		CIRCUIT BOARD ASSEMBLY--STORAGE A4
	- - - - - -			-		circuit board assembly includes:
	388-1983-00			1		CIRCUIT BOARD
-119	131-0589-00			4		TERMINAL, pin, 0.50 inch long
	131-0608-00			7		TERMINAL, pin, 0.365 inch long
-120	136-0252-04			45		SOCKET, pin connector
-121	175-0856-00			ft		WIRE, electrical, 9 wire ribbon, 3 inches long
-122	175-0863-00			1		WIRE, electrical, 2 wire ribbon, 18 inches long
-123	214-1612-00			1		HEATSINK, transistor
-124	214-1611-00			5		HEATSINK, transistor
	- - - - - -			-		mounting hardware for each: (not included w/heatsink)
-125	211-0007-00			1		SCREW, 4-40 x 0.188 inch, PHS
-126	210-0004-00			1		WASHER, lock, internal, 0.12 ID x 0.26 inch OD
-127	260-1207-00			1		SWITCH, push--STORE
-128	260-1223-00			1		SWITCH, push--ERASE
-129	260-1232-00			1		SWITCH, push--ERASE SELECT
-130	361-0411-00			10		SPACER, push switch
	- - - - - -			-		mounting hardware: (not included w/circuit board assembly)
-131	211-0008-00			4		SCREW, 4-40 x 0.25 inch, PHS
-132	366-1023-01[1]			1		KNOB, dark gray--POSITION
	- - - - - -			-		knob includes:
	213-0153-00			1		SETSCREW, 5-40 x 0.125 inch, HHS
-133	358-0378-00[1]			1		BUSHING, sleeve
-134	426-0681-00[1]			5		FRAME, pushbutton, front panel trim
-135	333-1439-00[1]			1		PANEL, front
-136	426-0766-00[1]			1		FRAME ASSEMBLY
-137	344-0226-00[1]			1		CLIP, ribbon wire
-138	366-1257-46[1]			1		PUSHBUTTON--ERASE
-139	366-1257-44[1]			2		PUSHBUTTON--UPPER
-140	366-1257-45[1]			2		PUSHBUTTON--LOWER
-141	333-1413-00[1]			1		PANEL, rear

[1]D13 only

Blue reference numbers denote parts which are not common to both instruments.



MANUAL CHANGE INFORMATION

At Tektronix, we continually strive to keep up with latest electronic developments by adding circuit and component improvements to our instruments as soon as they are developed and tested.

Sometimes, due to printing and shipping requirements, we can't get these changes immediately into printed manuals. Hence, your manual may contain new change information on following pages.

A single change may affect several sections. Sections of the manual are often printed at different times, so some of the information on the change pages may already be in your manual. Since the change information sheets are carried in the manual until ALL changes are permanently entered, some duplication may occur. If no such change pages appear in this section, your manual is correct as printed.

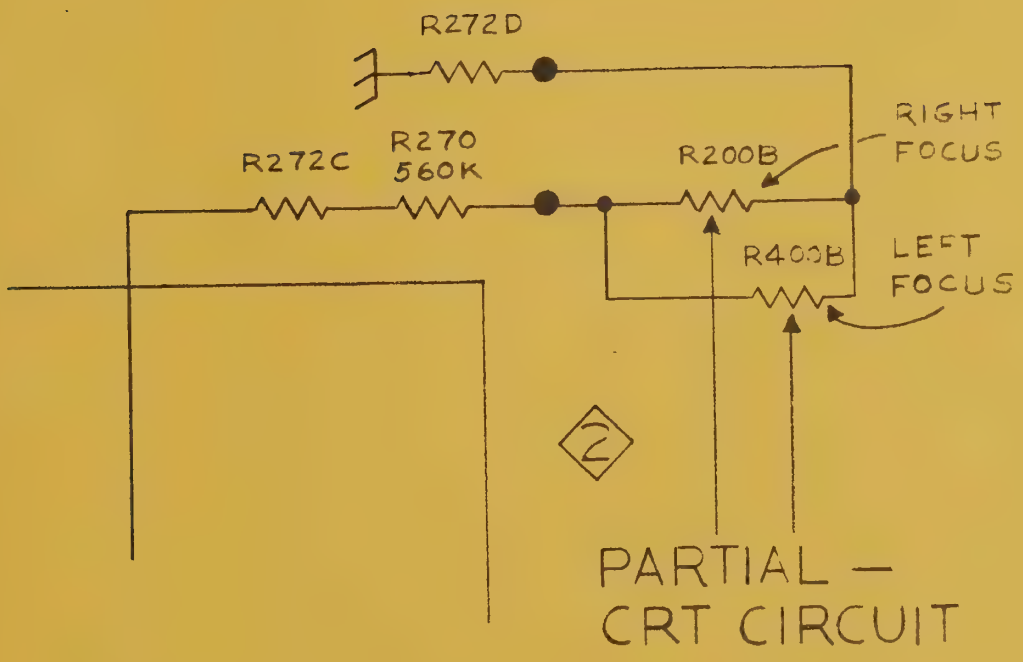
D12/D13 EFF SN B060000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

Page 4-7

ADD:

R270	302-0564-00	560 kΩ, 1/2 W, 10%



D12/D13 EFF SN B060000-up

ELECTRICAL PARTS LIST AND SCHEMATIC CORRECTION

CHANGE TO:

R148	304-0473-00	47 kΩ, 1W, 10%